AD-A014 470

CHANGES IN HELICOPTER RELIABILITY/MAINTAINABILITY CHARACTERISTICS OVER TIME. VOLUME 2. DATA SUBMITTED BY HELICOPTER MANUFACTURERS

Norman J. Asher, et al

Institute for Defense Analyses

Prepared for:

Office of the Director of Defense Research and Engineering
Defense Advanced Research Projects Agency

March 1975

STUDY S-451

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Volume 2: Data Submitted by Helicopter Manufacturers

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INSTITUTE FOR DEFENSE ANALYSES
PROGRAM ANALYSIS DIVISION

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This report examines the growth (or lack of it) in reliability and maintainability (R&M) characteristics of past helicopter programs and organizes the data so that they can be used as bases for predicting the R&M characteristics of future helicopter programs. Six types of R&M data are presented: (1) failure rates, (2) component-removal rates, (3) mishap rates, (4) maintenance-action rates, (5) operational

20. cont'd

availability, and (6) maintenance man-hours. Many of the data on past helicopter programs are included in the report, so that they will be available for use by analysts.

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Contract DAHC15 73 C 0200
Task T-105

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*Three pagination sequences are used in this volume: in both Part A (BV-) and Part B (H-), the lower-case Roman and the Arabic page numbers agree with those in each of the documents here reproduced; in Part C, however, the original page numbers of the two Sikorsky documents are displayed as they were submitted (i.e., centered at the lower edge), but with our single continuous (S-) pagination also indicated (in the lower unbound corner of each page). For the reader's additional convenience, Part B (Hughes) and Part C. II (Sikorsky) are printed on paper of a different color from that used for Part A (Boeing Vertol) and Part C.I (Sikorsky).

Because of the bulk of the Sikorsky reports, only the most interesting sections of them are reproduced in this volume.

Part A

Data Submitted by Boeing Vertol

D210-10877-1

RELIABILITY GROWTH ANALYSIS - FINAL REPORT

Prepared By
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ATTENTION
Mr. Norman J. Asher
Ass't Division Director

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FOREWORD

This report presents a study to identify Reliability, Maintainability, and Safety Growth Trends on helicopters. The work was conducted under Contract Number P. O. 20478 for the Institute of Defense Analysis (IDA), Arlington, Virginia.

IDA technical direction was provided by Mr. Norman J. Asher.

Project Engineer for the Boeing Vertol Company was Mr. J. J. Dougherty, III of the Product Assurance R&D unit. Principal Investigator for the study was Mr. O. L. Sandora, also of the Product Assurance R&D unit. Program Management and Technical Direction were provided by Mr. K. G. Rummel, Manager, Product Assurance Research & Development.

1. INTRODUCTION

Helicopters have consistently exhibited relatively high unscheduled maintenance requirements because of the great percentage of high reliability risk and high-cost components needed for the helicopters unique performance capabilities. This tendency towards high maintenance requirements has generated concurrence among both the contractor and customer that improved reliability must be achieved without a long and expensive period of in-service product improvement. High initial reliability can be achieved only through a well-executed analytical design approach and an enthusiastic and well-controlled developmental testing effort.

The primary reliability effort in the design stage is the analysis and evaluation of the aircraft design and development of Reliability Predictions. Recent work has shown that a point estimate of aircraft or component reliability is meaningless unless accompanied by a quantification of the time in the components maturity (development) cycle for which the estimate is relevant.

Reliability growth prediction techniques have been employed to estimate the number of developmental test hours required to achieve a desired level of reliability with increased confidence in the technology.

However, since reliability continues to be improved by the Product Improvement process throughout most of the in-production life of a helicopter, it is necessary to understand this growth process. The magnitude and the factors affecting this growth process must be determined and quantified if future aircraft programs are to be optimized. Development costs and O&M costs must be viewed as intimately related to reliability. The key to minimum total system costs is the understanding of the reliability growth process through the development and operational phases.

2. DOCUMENTATION OF ANALYSIS

Historically, reliability of helicopters has increased with each new generation of aircraft, as well as increasing during the in-service phase of each individual aircraft. In order to understand these growth patterns and the impact that aircraft reliability growth has on mission reliability, safety reliability, availability and maintenance manhour expenditures, an analysis of in-service aircraft data is essential.

This can best be achieved with a compilation of reliability growth experience at the aircraft component level, and the impact on the above mentioned parameters after component reliability is analyzed: then total aircraft reliability should be examined and conclusions drawn concerning the factors affecting this growth process.

The data contained in the following chart identifies all pertinent information developed under this contract and contained in this report.

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CHECKED BY
DATE

MODEL NO

NUMBER
REV LTR

TABLE 1 - CH-47 SYSTEM REM GROWTH STATISTICS

MALFUNCTIONS PER FLIGHT HOUR

Flight Hrs	Year	[illegible] λ	Cum λ	Power Plant λ	Cum λ	Flight Control λ	Cum λ	Drive λ	Cum λ	Rotor λ	Cum λ	Indicating λ	Cum λ	Electrical λ	Cum λ	Equipment λ	Cum λ	Comm/Nav λ	Cum λ	Hydraulic λ	Cum λ	Landing Gear λ	Cum λ	Total λ	Cum λ
[illegible]	[illegible]	.200	.31	.290	.29	.235	.23	.112	.11	.100	.100	.090	.090	.085	.085	.060	[illegible]	[illegible]	.075	.050	.050	.037	.037	1.954	1.659
[illegible]	[illegible]	.200	.31	.290	.29	.235	.23	.112	.11	.100	.100	.090	.090	.085	[illegible]	[illegible]	[illegible]	[illegible]	.075	.050	.050	.037	.037	1.954	[illegible]
[illegible]	1967	.255	.27	.195	.23	.105	.16	.180	.15	.090	.094	.075	.081	.030	[illegible]	[illegible]	[illegible]	[illegible]	.075	.030	[illegible]	.030	.033	1.125	1.277
[illegible]	1968	.355	.31	.205	.22	.100	.13	.177	.16	.090	.088	.065	.071		.048	2	[illegible]	.028	[illegible]	.040	.037	.040	.035	1.199	1.200
[illegible]	1969	.500	.32	.225	.22	.030	.10	.210	.18	.060	.079	.060	.067	[illegible]	[illegible]	[illegible]	[illegible]	.8	.041	.025	.033	.015	.028	1.098	[illegible]
[illegible]	1970	.450	.35	.330	.25	.088	.09	.110	.13	.032	.067	.100	.075	[illegible]	[illegible]	.045	[illegible]	[illegible]	.41	.030	.32	.015	.025	1.358	[illegible]
[illegible]	1971	.443	.37	.330	.26	.055	.09	.168	.13	.081	.069	.075	.075	[illegible]	[illegible]	[illegible]	.050	[illegible]	[illegible]	.034	.33	.020	.022	1.360	[illegible]
[illegible]	1972	.306	.36	.260	.26	.070	.09	.094	.17	.093	.071	.038	.073	[illegible]	[illegible]	[illegible]	.051	.025	.038	[illegible]	.33	.019	.024	1.092	[illegible]
[illegible]	1963	← SYSTEM BREAKDOWN NOT AVAILABLE →																						2.20	2.20
[illegible]	1969																							1.50	[illegible]

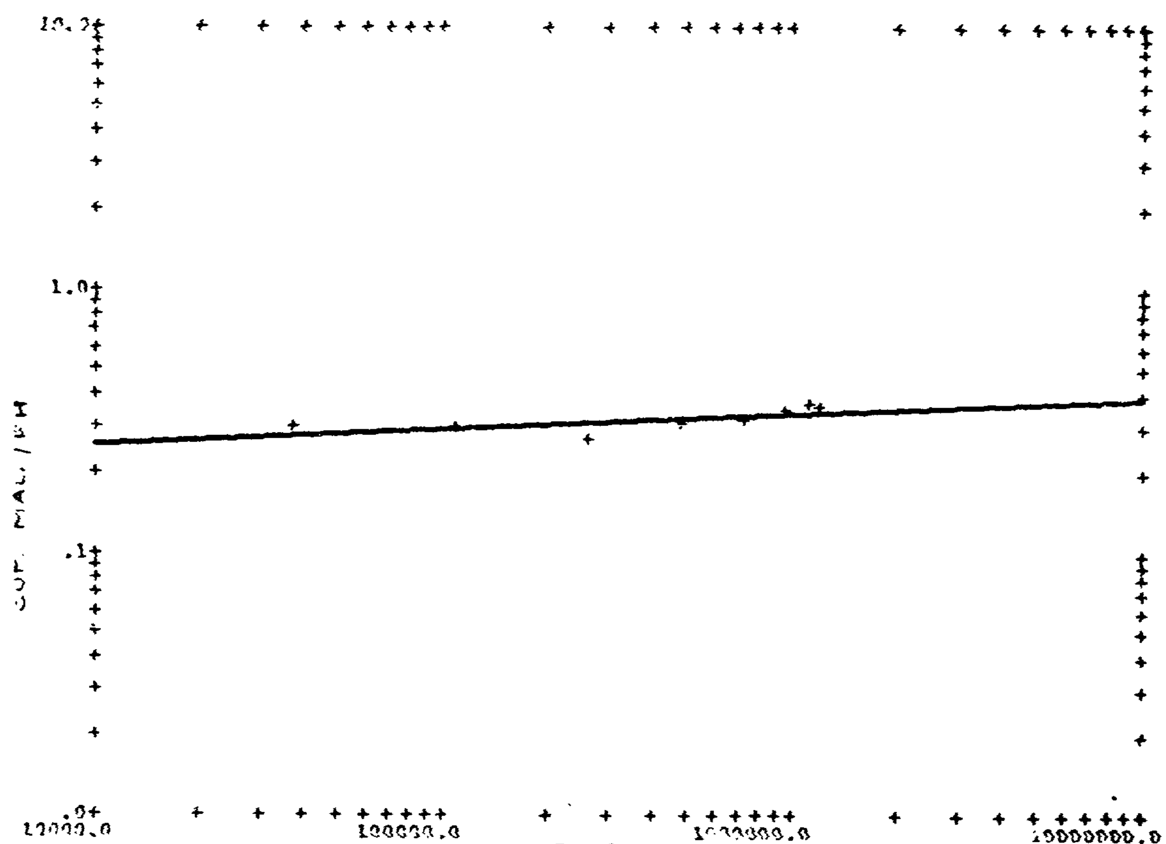
MAINTENANCE MAN HOURS PER FLIGHT HOUR
(ORGANIZATIONAL + INTEGRATED DIRECT SUPPORT)

Flight Hrs	Year	Δ	Cum Δ	Δ	Cum Δ	Δ	Cum Δ	Δ	Cum Δ	Δ	Cum Δ	Δ	Cum Δ	Δ	Cum Δ	Δ	Cum Δ	Δ	Cum Δ	Δ	Cum Δ	Δ	Cum Δ	Δ	Cum Δ
[illegible]	1965	.743	1.430	.790	[illegible]	.550	[illegible]	.220	.170	.650	.650	.150	[illegible]	[illegible]	.100	.350	.100	.120	.120	[illegible]	.100	.100	.100	5.310	5.310
[illegible]	1966	[illegible]	.430	[illegible]	[illegible]	.550	.560	[illegible]	.970	.65	.650	[illegible]	[illegible]	[illegible]	.160	[illegible]	.150	.120	.120	[illegible]	.100	[illegible]	.100	5.310	5.310
[illegible]	1967	[illegible]	1.628	[illegible]	[illegible]	[illegible]	.69	[illegible]	.601	[illegible]	.399	[illegible]	[illegible]	[illegible]	.165	[illegible]	.175	[illegible]	.118	[illegible]	.059	.050	.071	2.930	3.632
[illegible]	1968	[illegible]	1.307	[illegible]	[illegible]	[illegible]	.92	[illegible]	.528	[illegible]	.495	[illegible]	[illegible]	[illegible]	.250	[illegible]	.132	[illegible]	.077	[illegible]	.053	.060	.063	2.960	[illegible]
[illegible]	1969	[illegible]	.970	[illegible]	[illegible]	[illegible]	.51	[illegible]	.517	[illegible]	.333	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.121	[illegible]	.063	[illegible]	.048	.040	.055	3.040	[illegible]
[illegible]	1970	[illegible]	.935	[illegible]	.30	[illegible]	.38	[illegible]	.34	[illegible]	.317	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.106	[illegible]	.057	[illegible]	.056	.050	.054	3.360	[illegible]
[illegible]	1971	[illegible]	.911	1.006	[illegible]	[illegible]	.33	[illegible]	.15	.451	.346	[illegible]	[illegible]	[illegible]	[illegible]	.032	.101	.741	.155	.065	.058	.036	.052	3.286	[illegible]
[illegible]	1972	[illegible]	.908	[illegible]	[illegible]	[illegible]	.331	[illegible]	.506	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.199	[illegible]	.052	[illegible]	.58	.028	.050	2.716	3.229

*** - DATA SOURCE - BOEING VERTOL DATA BANK ***

SHEET

Best Available Copy

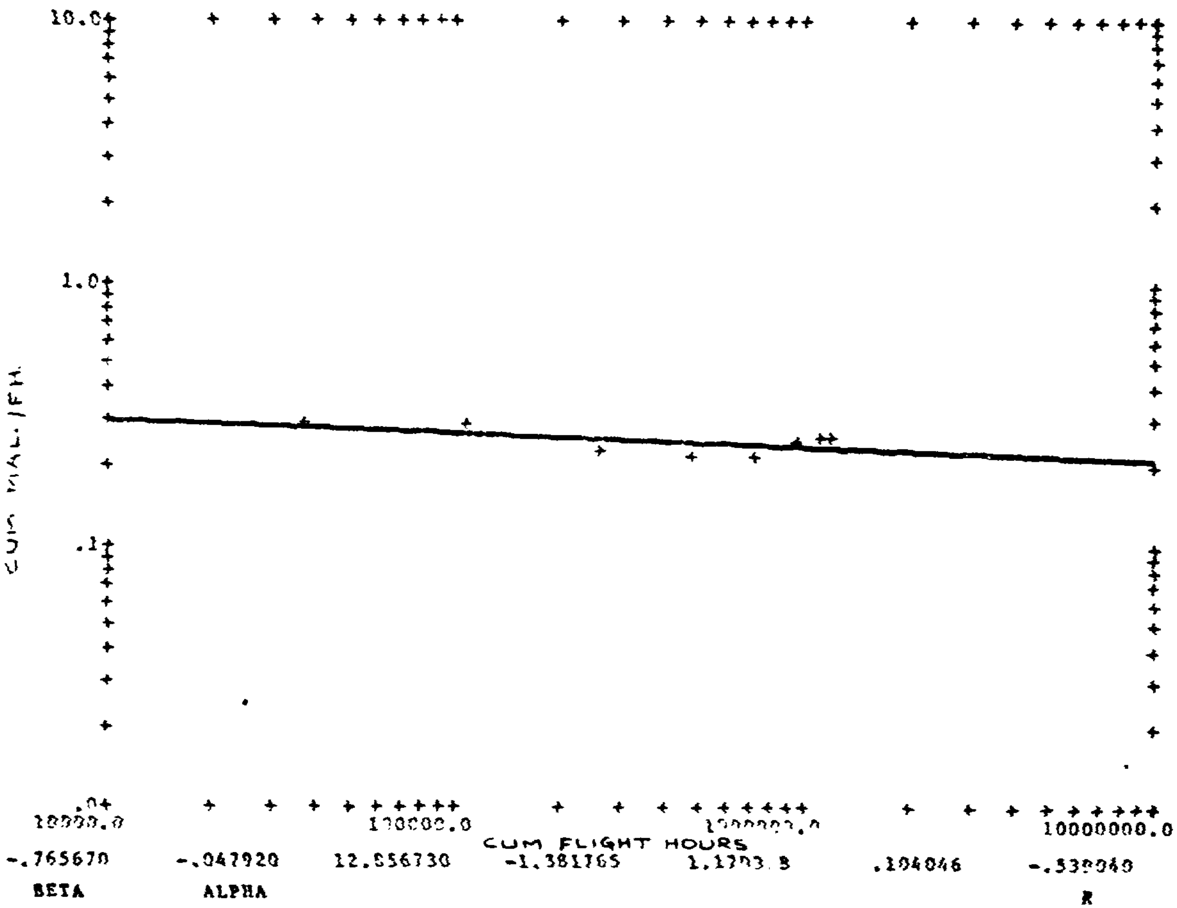


-1.015413	.069556	12.056730	-1.136702	1.1793.8	.100700	.703950
BETA	ALPHA	$\overline{X}$	$\overline{Y}$	σ_x	σ_y	R

AIRFRAME

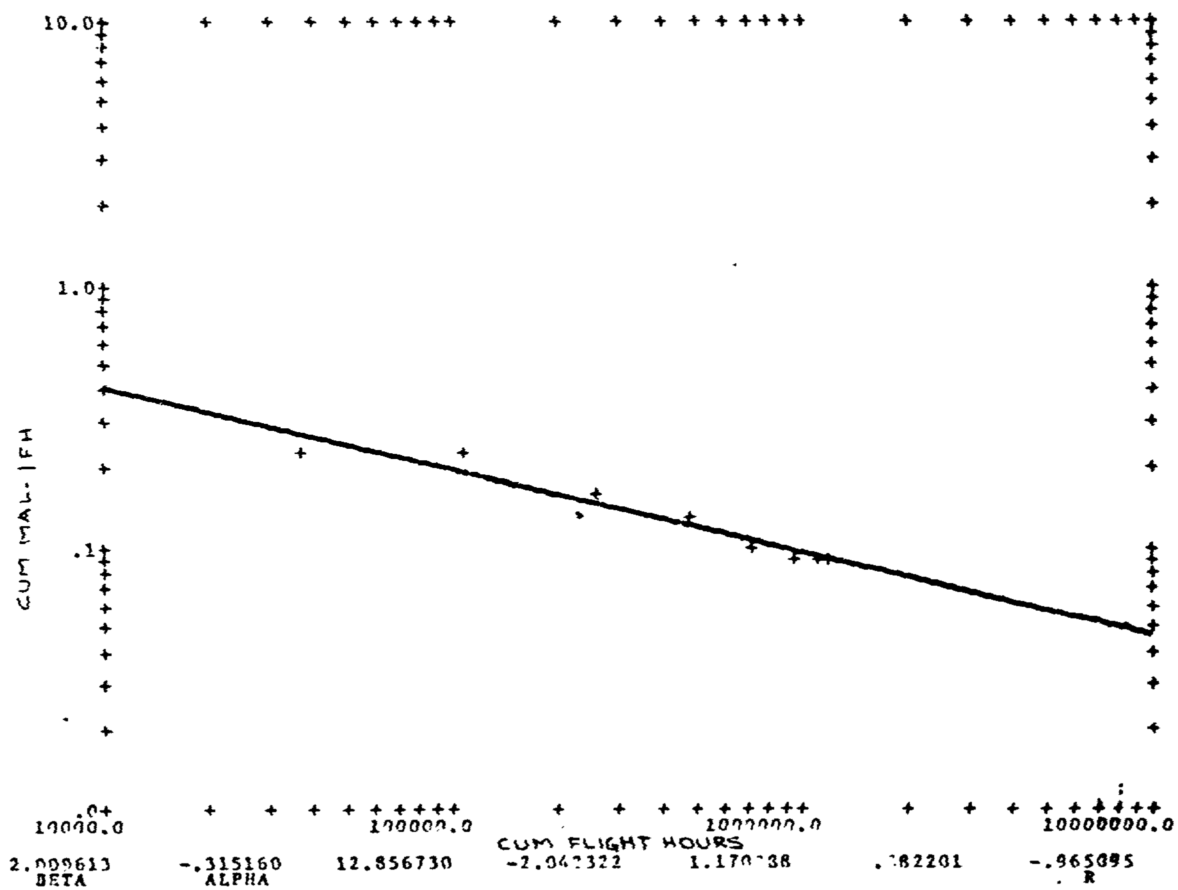
CH-47 MAL./FH- CUM

FIGURE 1



POWER PLANT
CH-47 MAL./FH- CUM

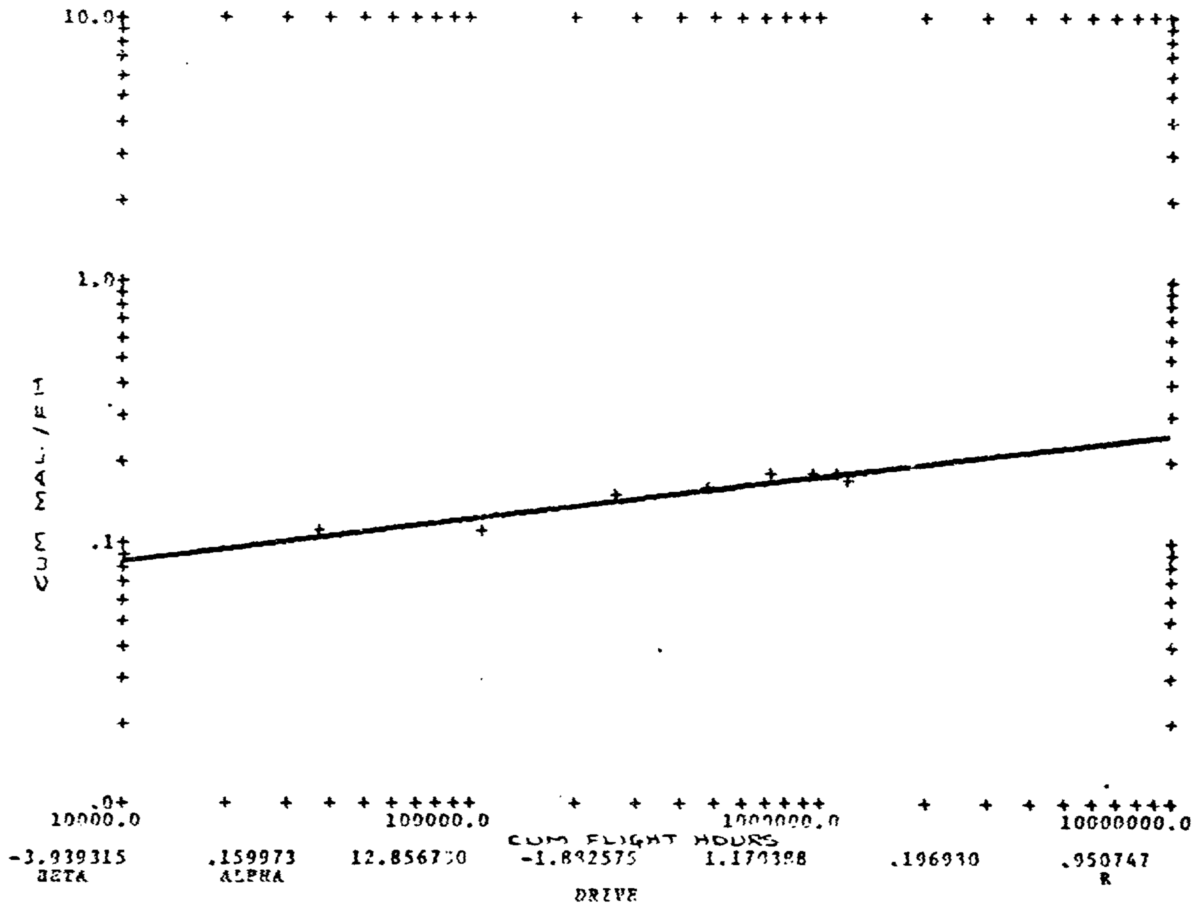
FIGURE 2



FLIGHT CONTROLS

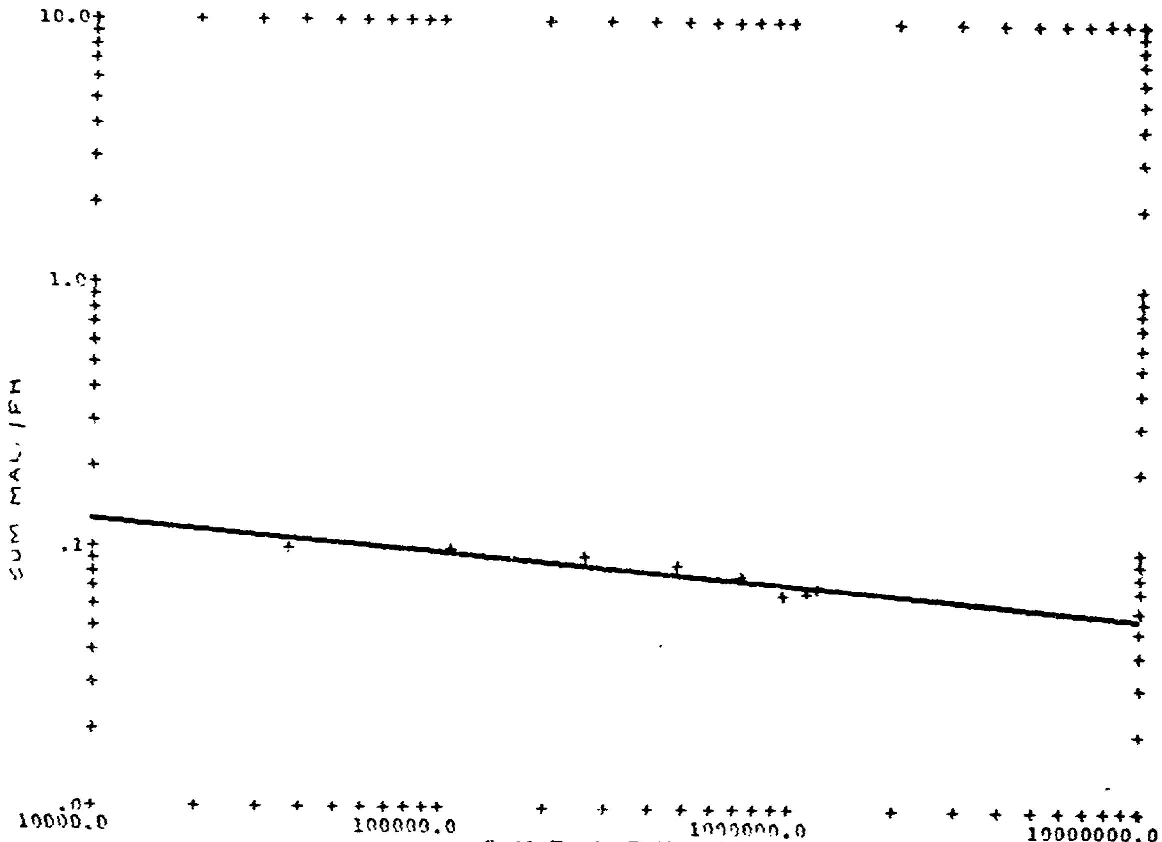
CH-47 MAL./FH- CUM

FIGURE 3



CH-47 MAL./FH- CUM

FIGURE 4



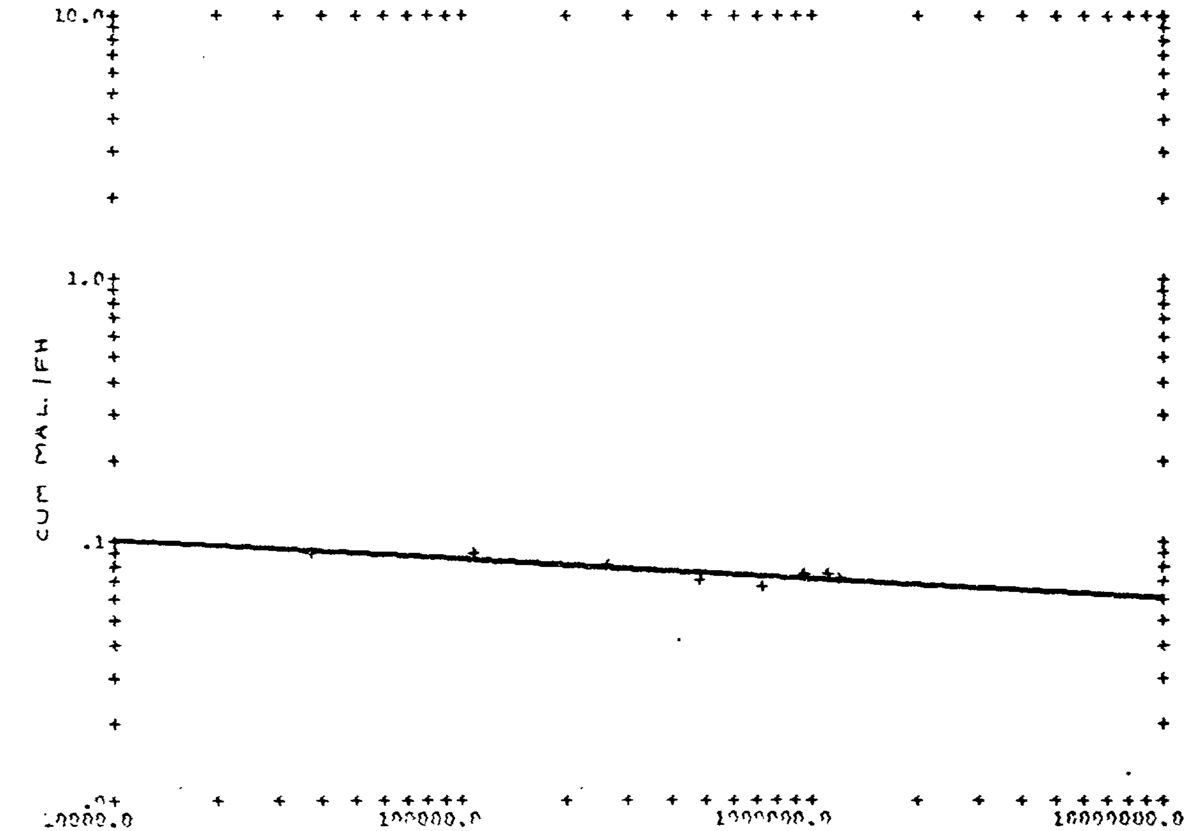
-.957282 -.228623 12.856730 -3.69501 1.170380 .156069 -.896997

BETA ALPHA R

ROTOR

CH-47 MAL./FH- CUM

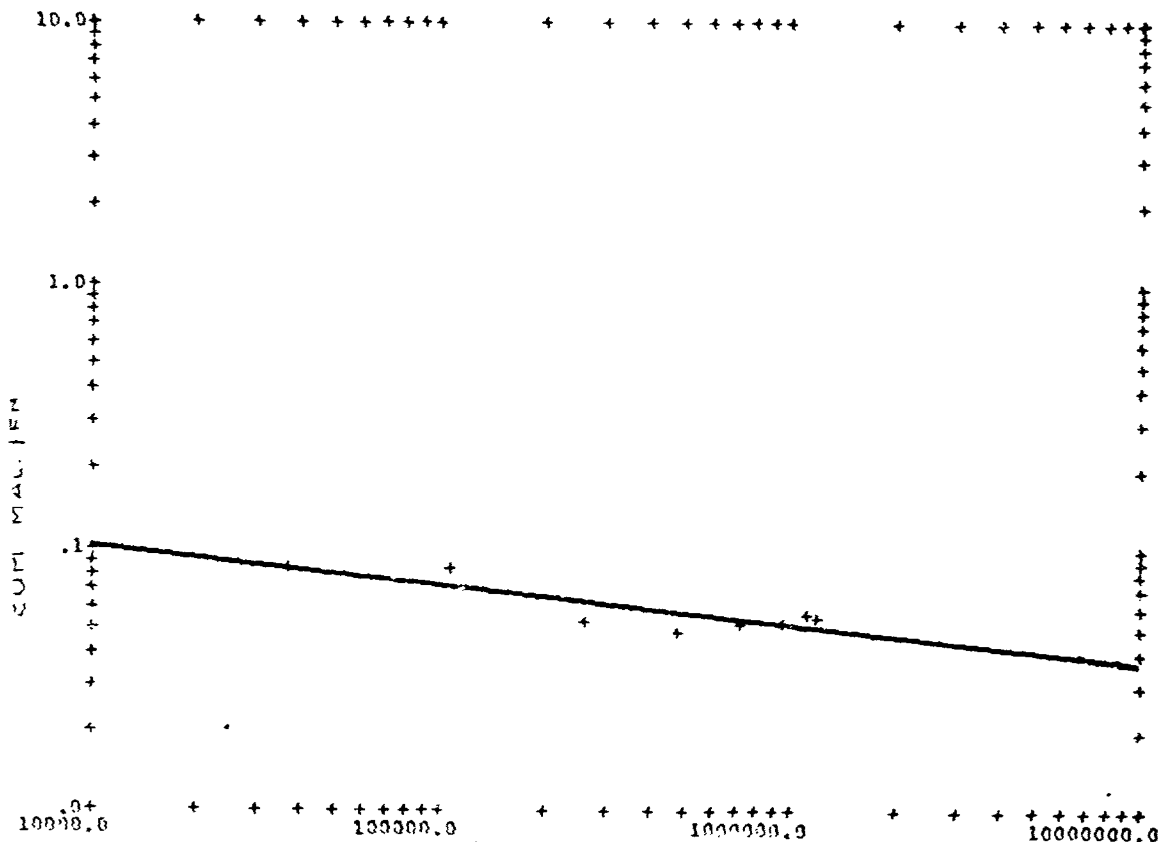
FIGURE 5



BETA	ALPHA					R
-1.619722	-.073119	12.856730	-2.559395	1.170388	.100770	-.849231

INDICATING
CH-47 MAL./FH- CUM

FIGURE 6

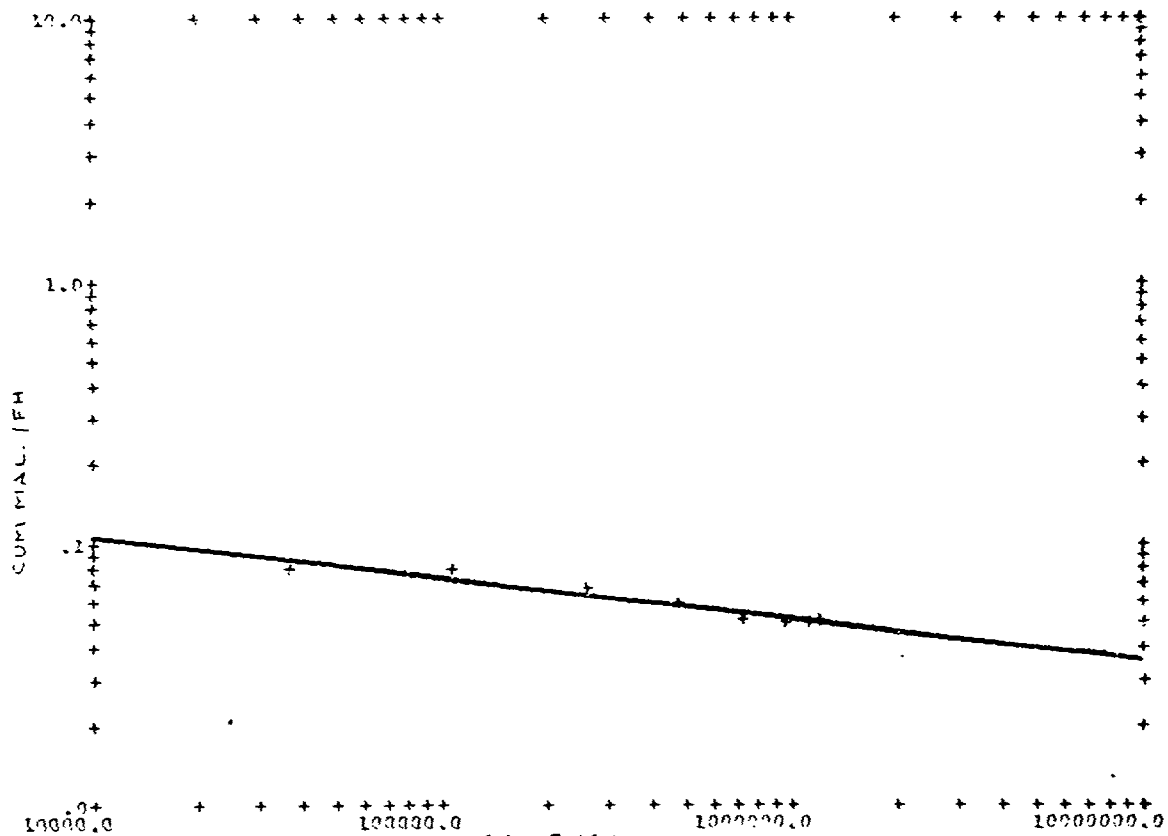


-.925753 BETA | -.147367 ALPHA | 12.856730 | -2.820415 | 1.170388 | .210206 | -.820513 R

ELECTRICAL

CH-47 MAL./FH- CUM

FIGURE 7

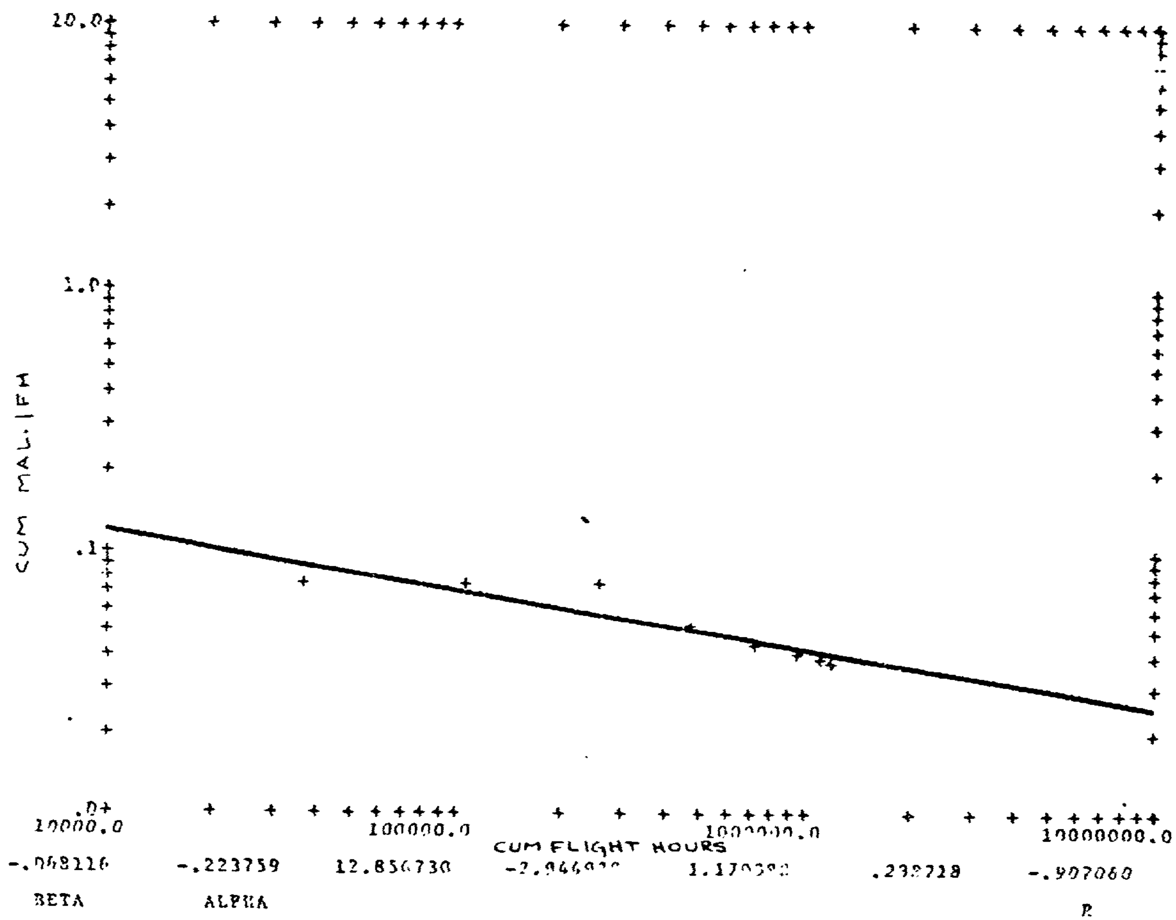


-.772550 -.158796 12.856730 -2.314155 1.170388 .193995 -.958510

BETA ALPHA R

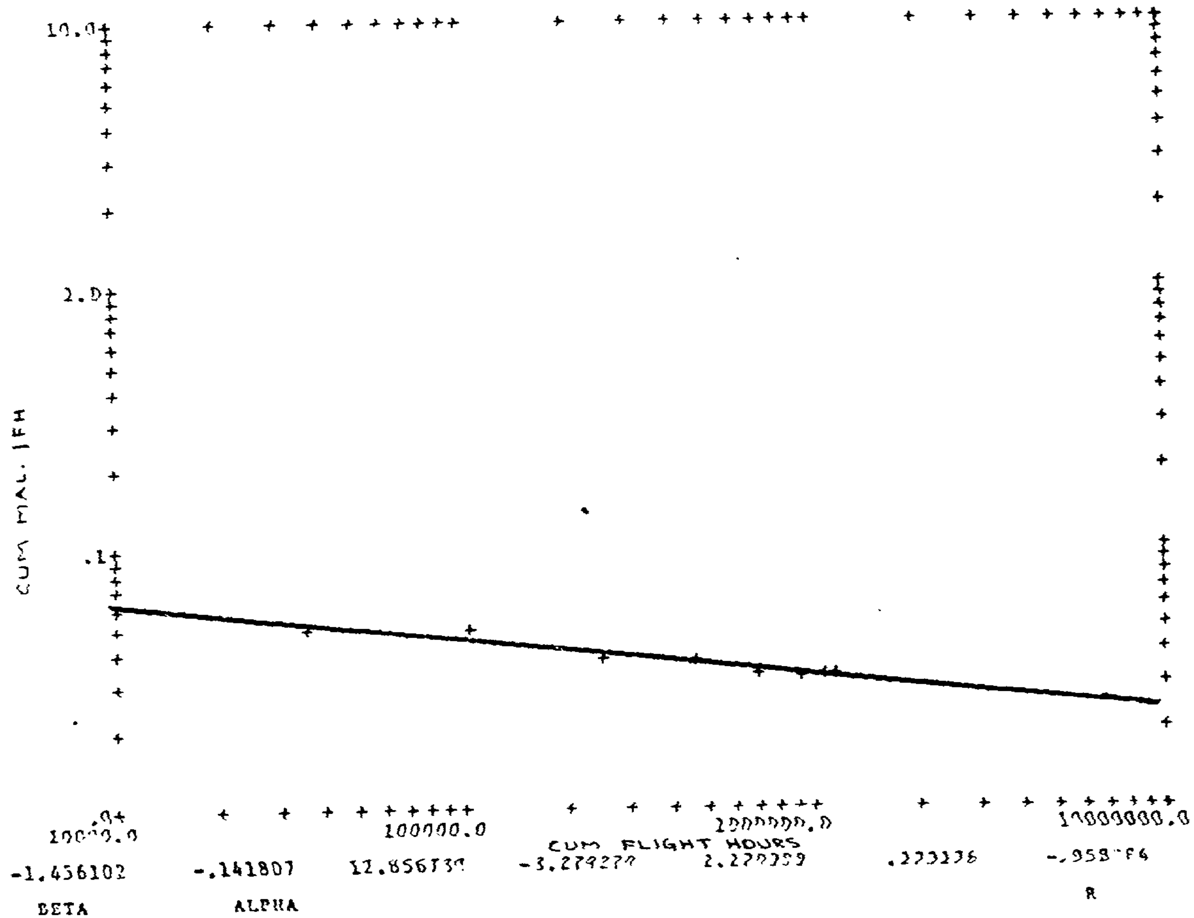
EQUIPMENT
CH-47 MAL./FH- CUM

FIGURE B



CH-47 MAL./FH- CUM

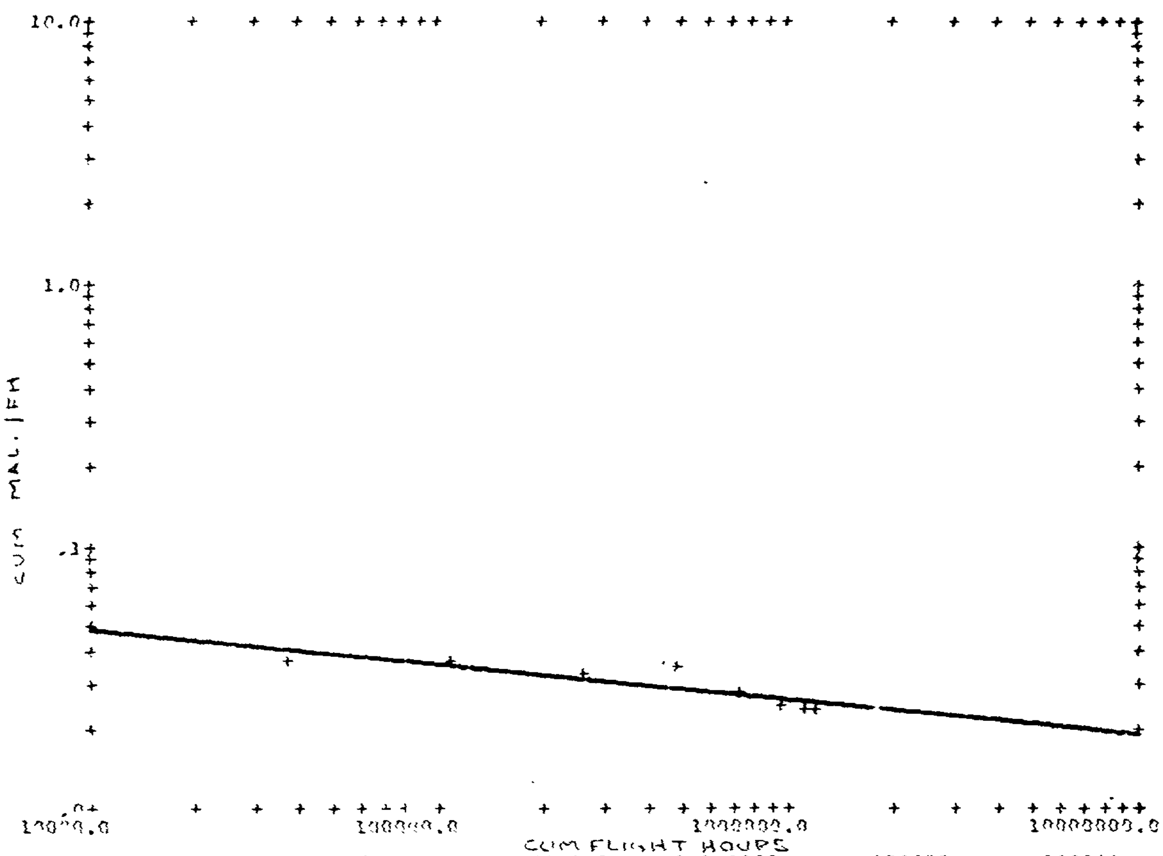
FIGURE 9



HYDRAULIC

CH-47 MAL./FH- CUM

FIGURE 10

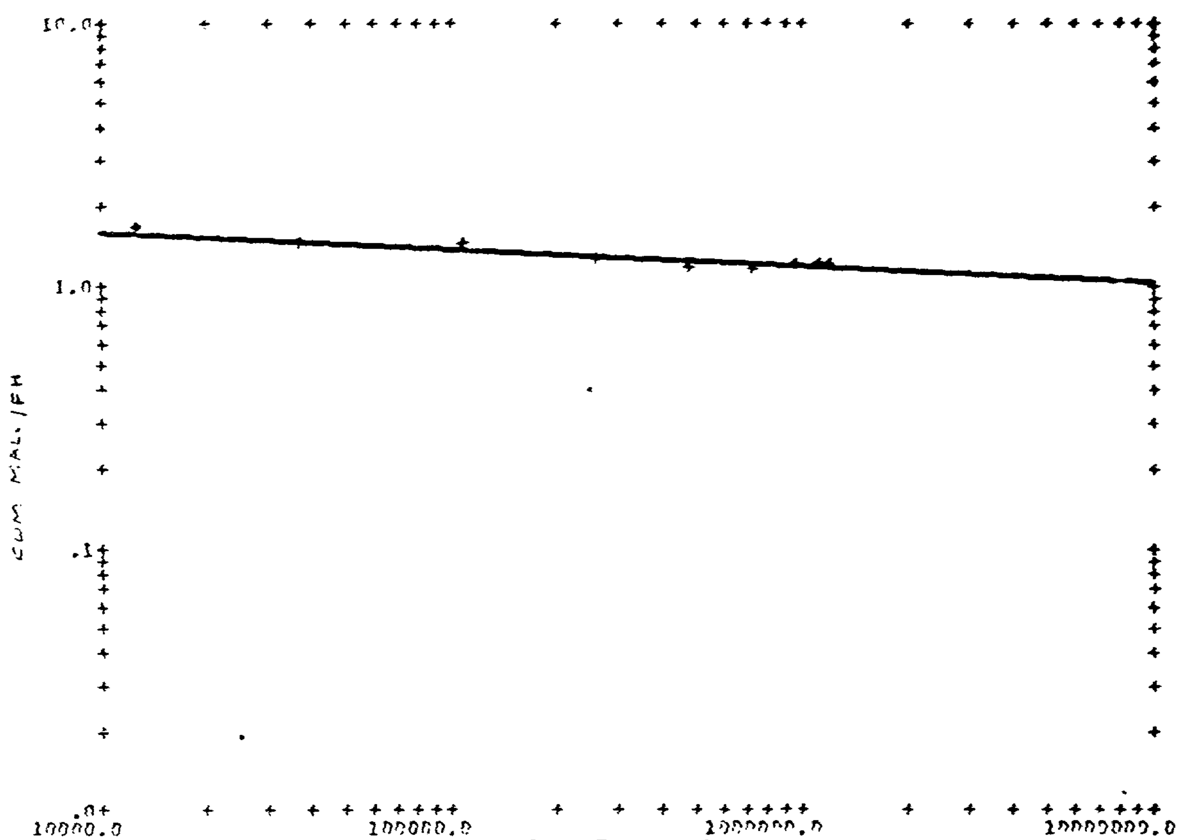


-1.79.794 -.133498 12.956730 -3.510145 1.1 0388 .179635 -.869544

BETA ALPHA R

LANDING GEAR
CH-47 MAL./FH- CUM

FIGURE 11



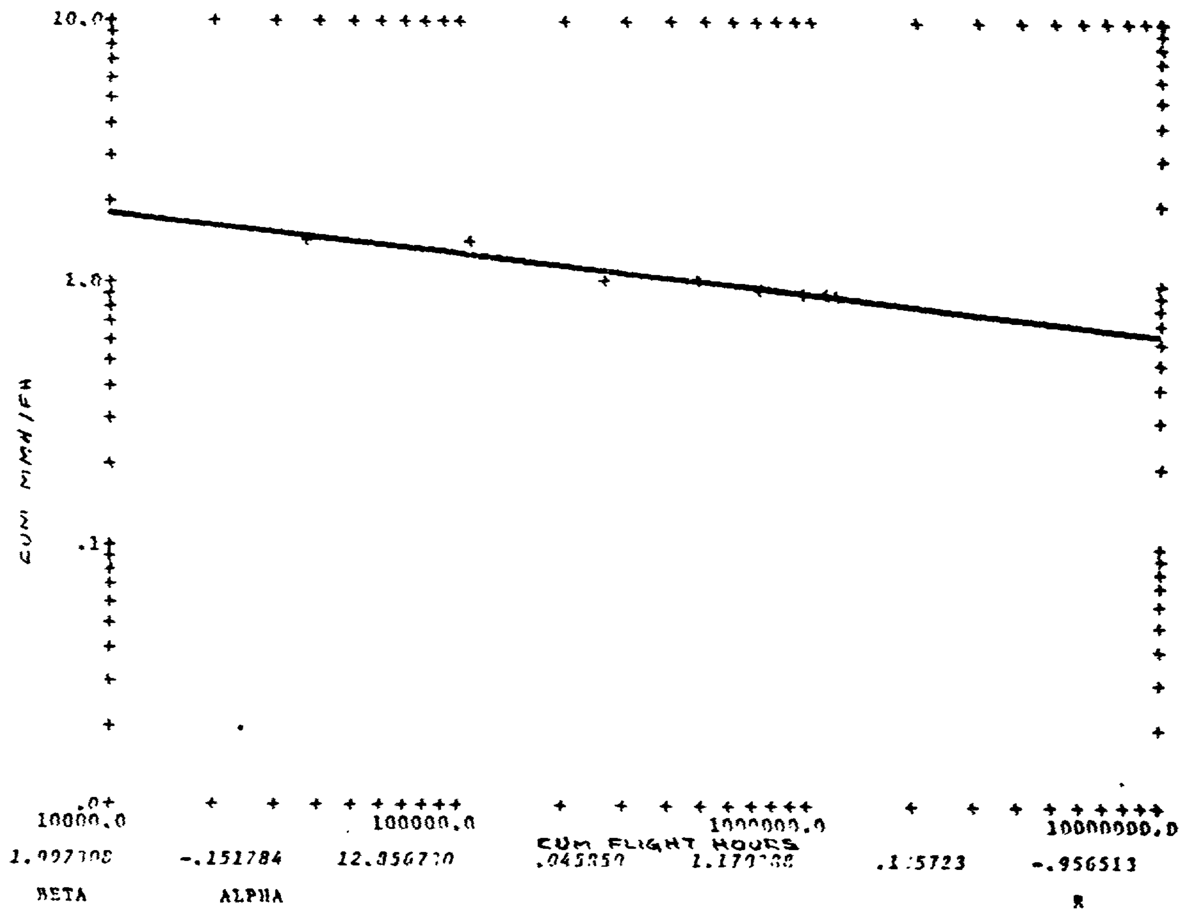
1.064228 -.063029 12.856730 -.2:3878 1.170388 .083419 -.384:07

BETA ALPHA R

TOTAL

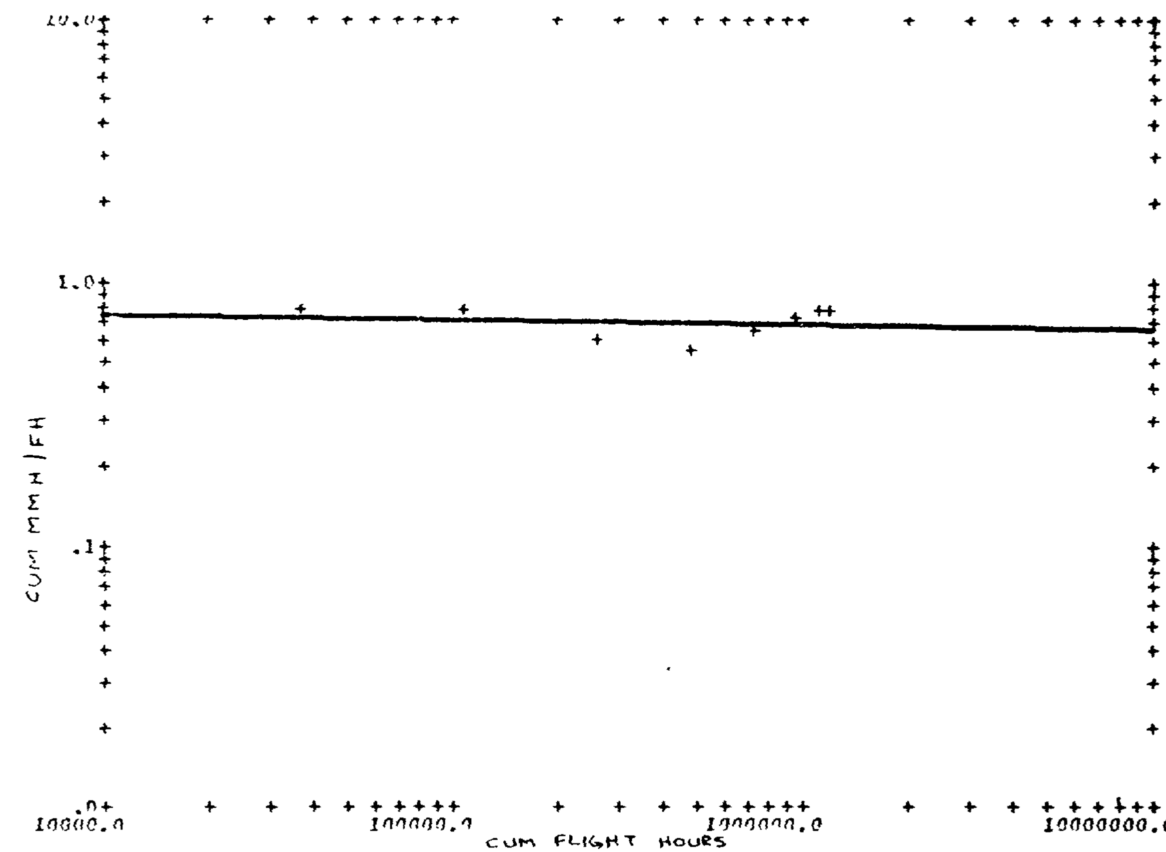
CH-47 MAL./FH- CUM

FIGURE 12



AIRFRAME
CH-47 MMH/FH- CUM

FIGURE 13

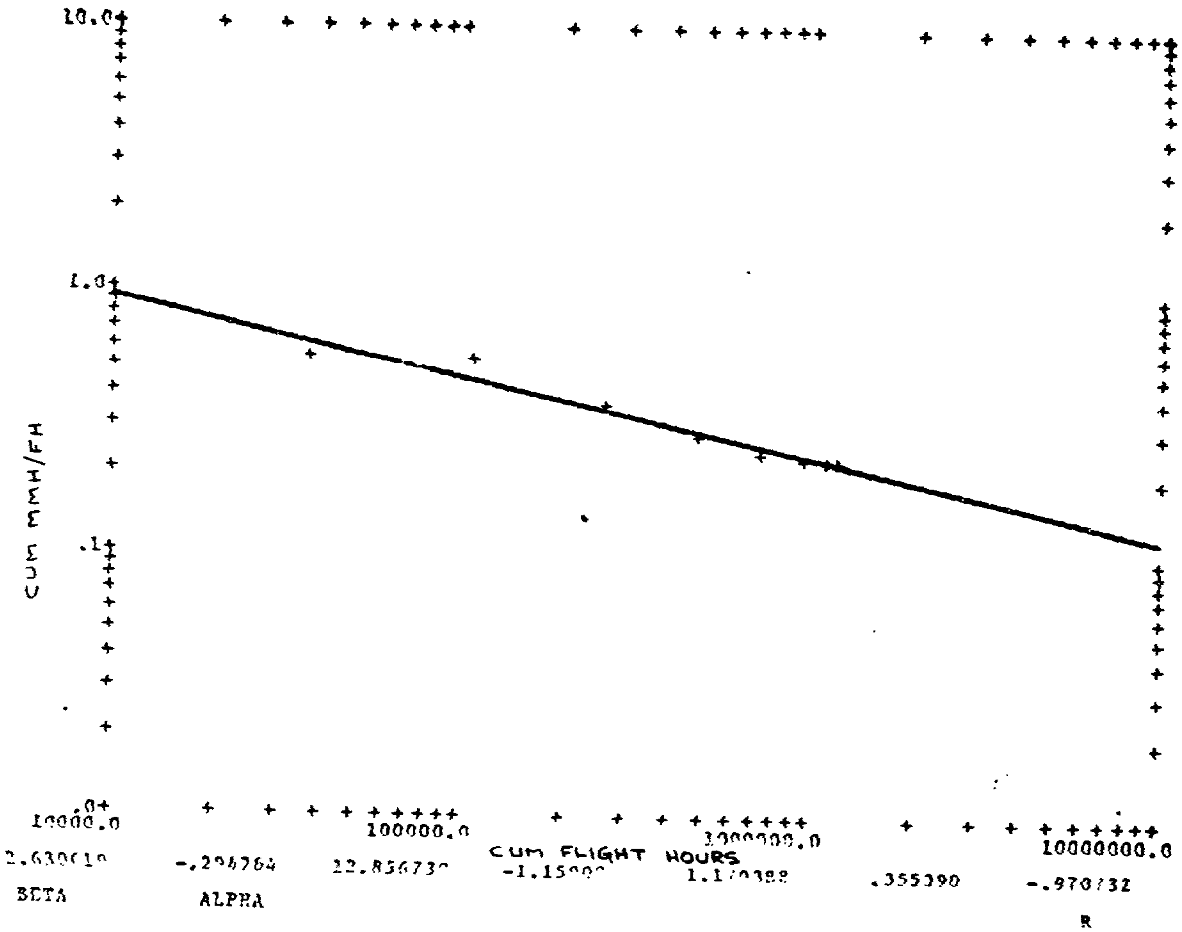


-.126767 -.017260 12.356730 -.48(5^ 1.170380 .12827: -.157487

BETA ALPHA R

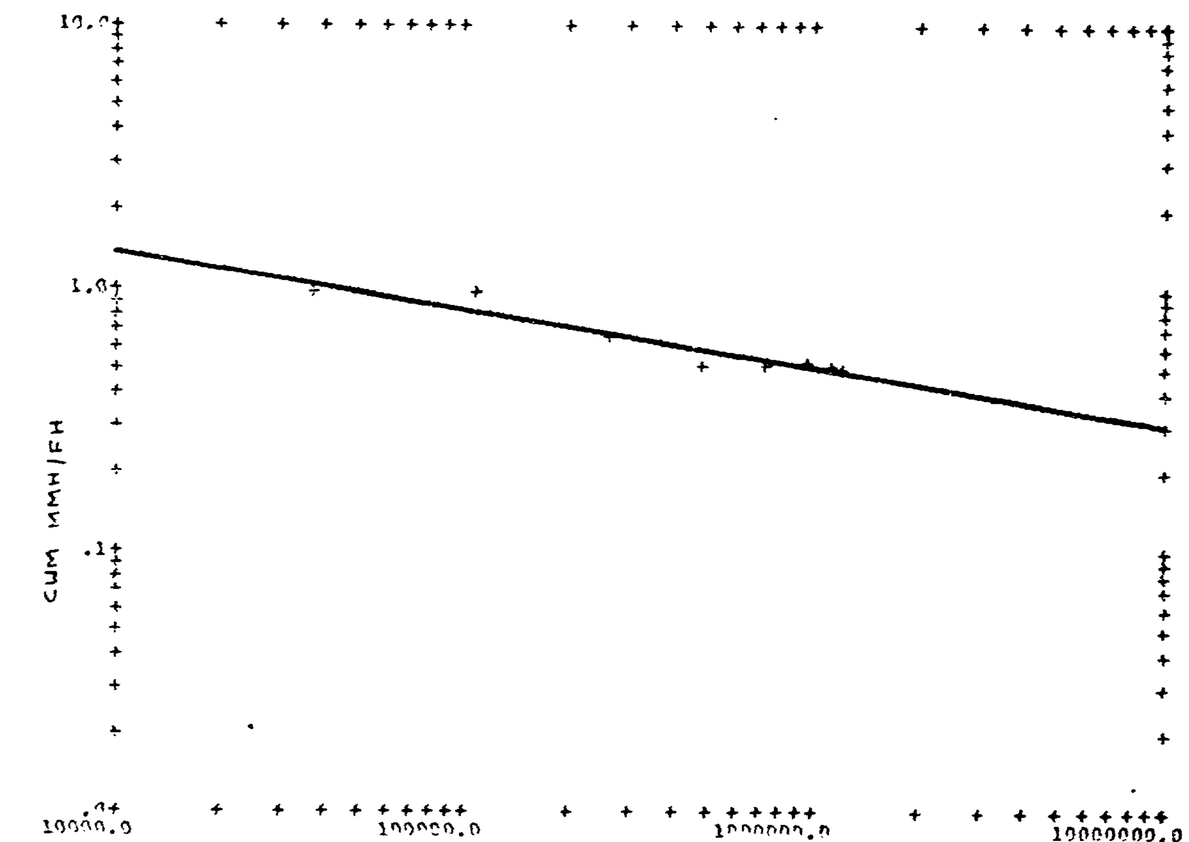
POWER PLANT
CH-47 MMH/FH- CUM

FIGURE 14



FLIGHT CONTROL
CH-47 MMH/FH- CUM

FIGURE 15

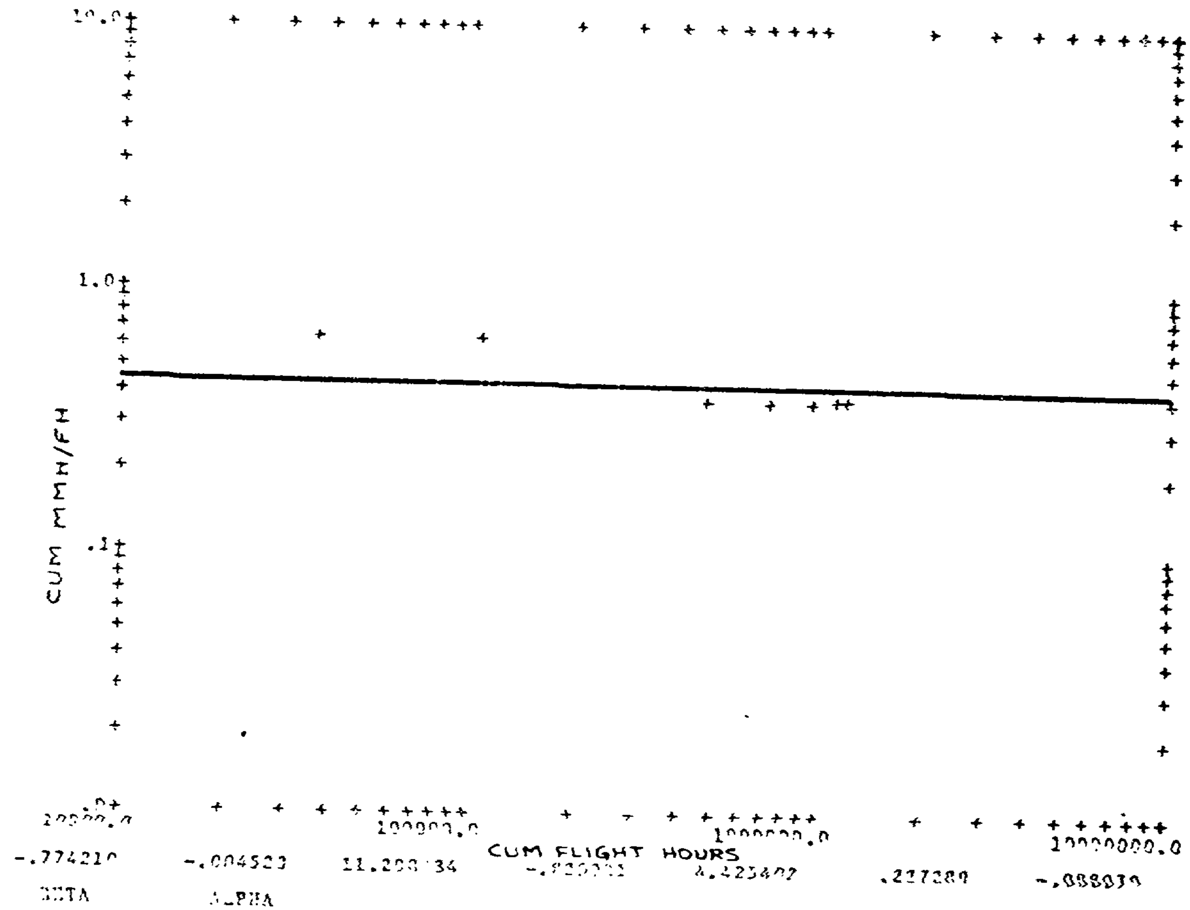


2.335700 -.218852 12.856700 -.4 8020 1.170389 .270067 -.948415

BETA ALPHA R

DRIVE
CH-47 MMH/FH- CUM

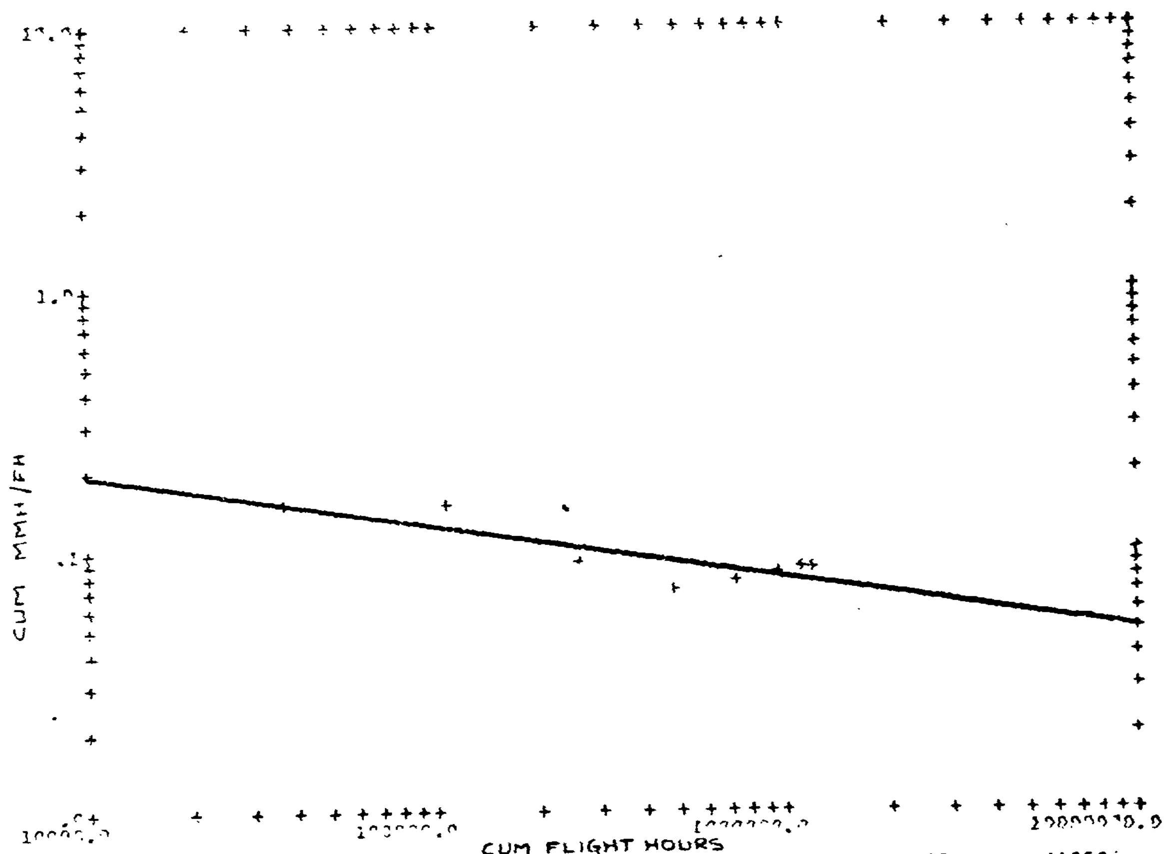
FIGURE 16



ROTOR

CH-47 MMH/FH- CUM

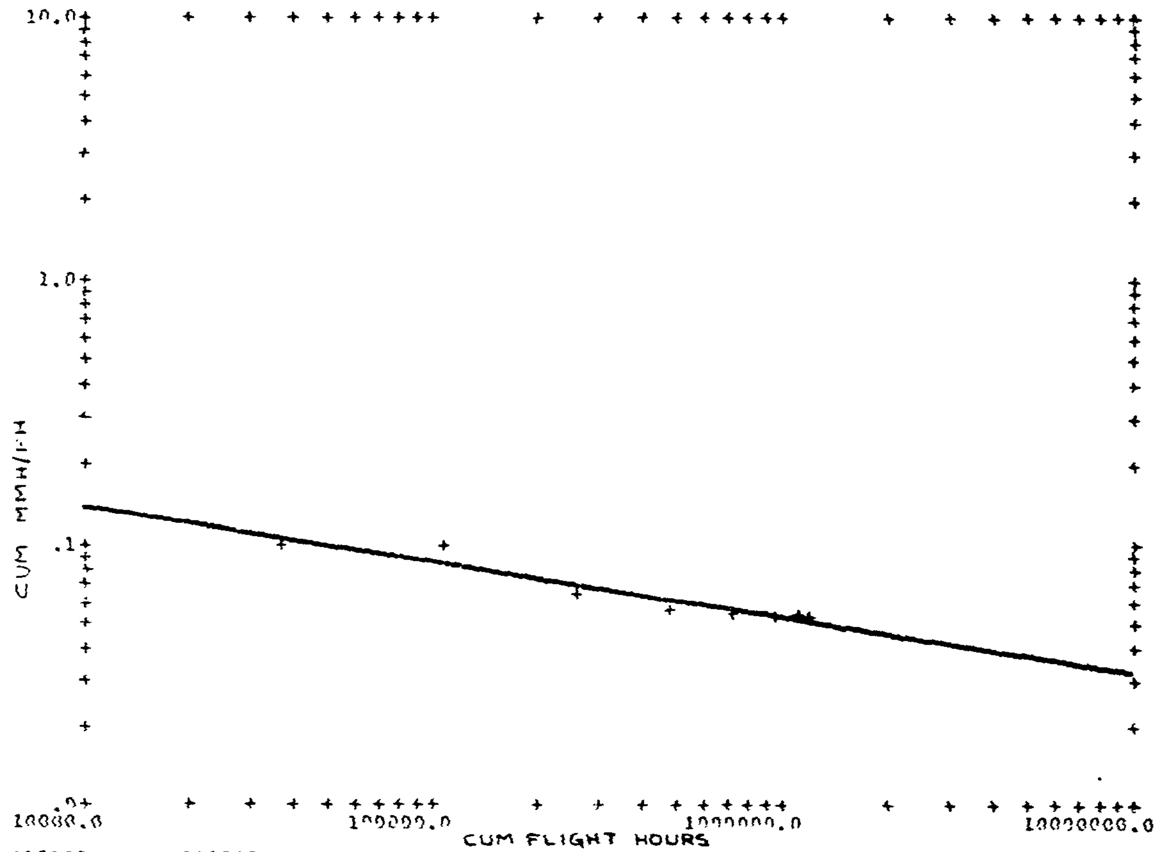
FIGURE 17



.186303	-.197259	12.956710	-2.349814	1.170.08	.272065	-.848523
BETA	ALPHA					R

INDICATING
CH-47 MMH/FH- CUM

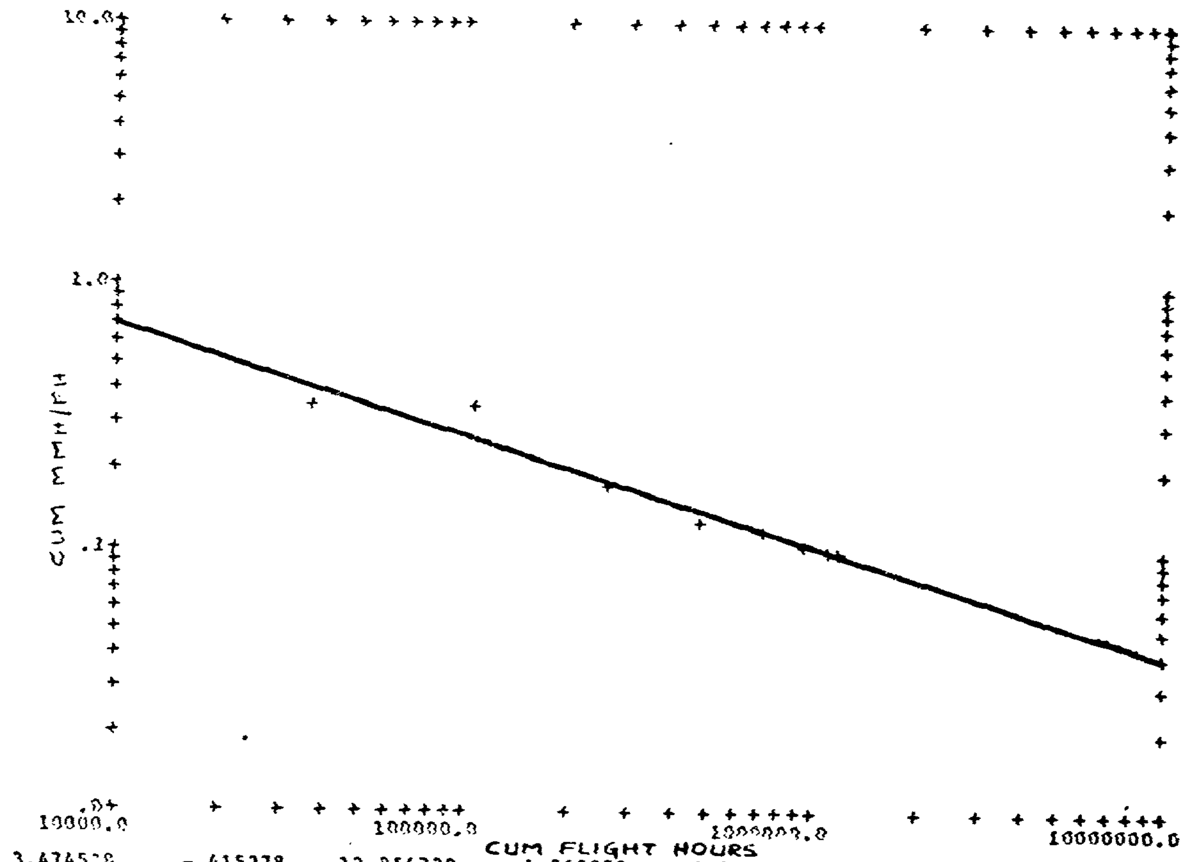
FIGURE 18



-.018162	-.222835	12.856730	-2.741676	1.170788	.260975	-.950013
BETA	ALPHA					R

ELECTRICAL
CH-47 MMH/FH- CUM

FIGURE 19



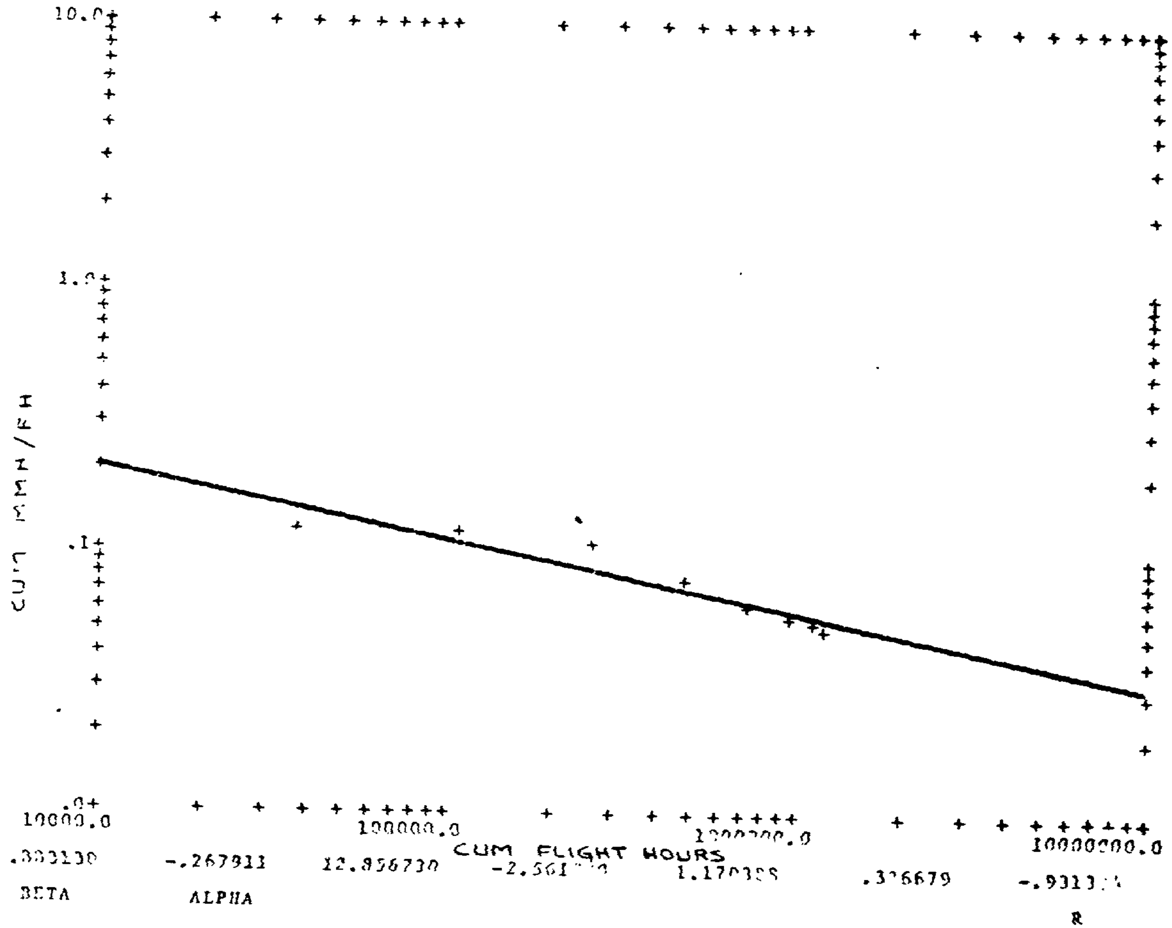
3.474518 -.415378 12.856739 -1.965075 1.110308 .501171 -.970032

BETA ALPHA R

EQUIPMENT

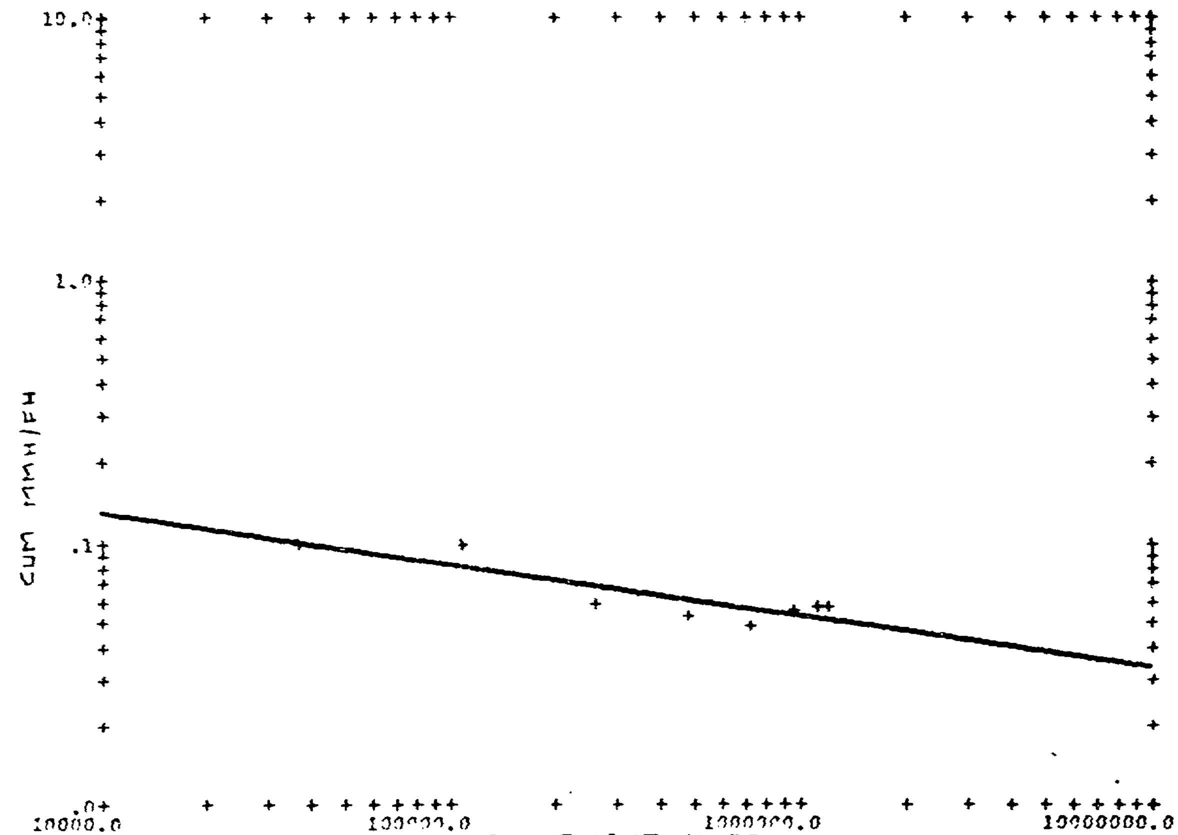
CH-47 MMH/FH- CUM

FIGURE 20



CH-47 MMH/FH- CUM

FIGURE 21

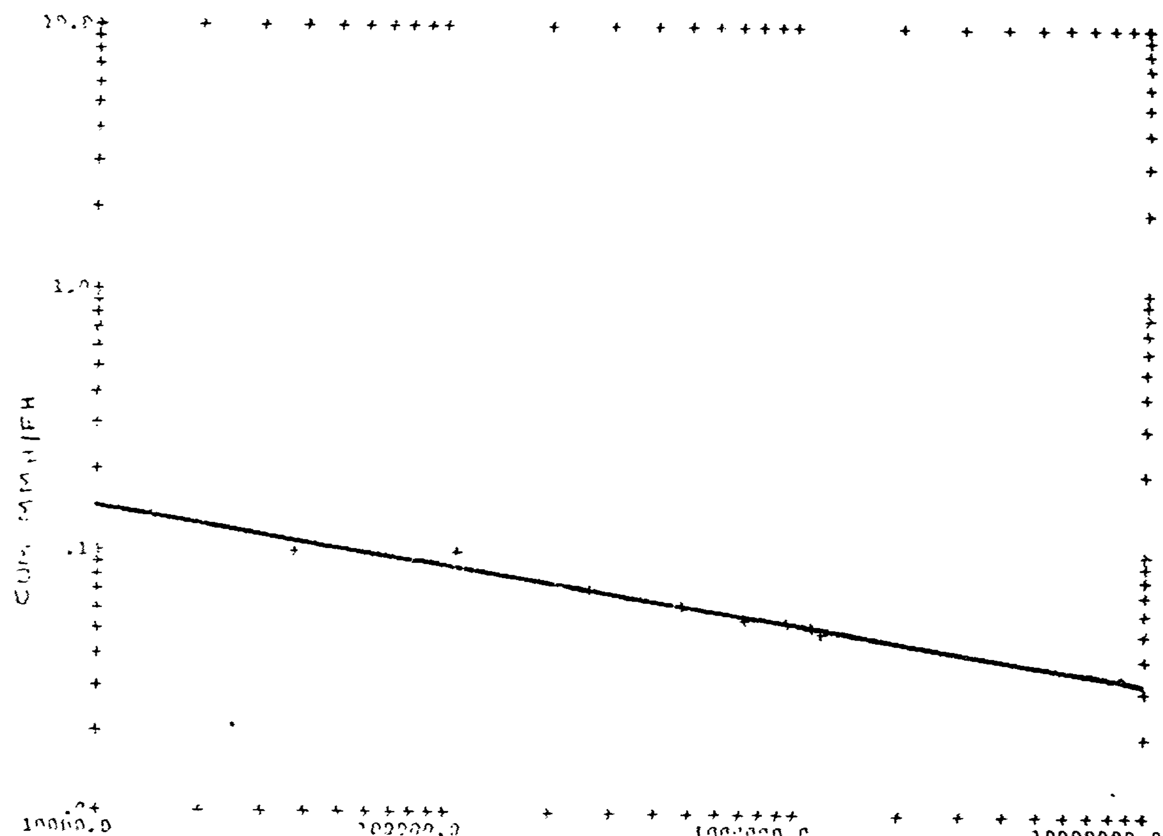


-.216424 -.195374 12.956730 -2.748304 1.170.80 .264692 -.863.86

BETA ALPHA R

HYDRAULIC
CH-47 MMH/FH- CUM

FIGURE 22



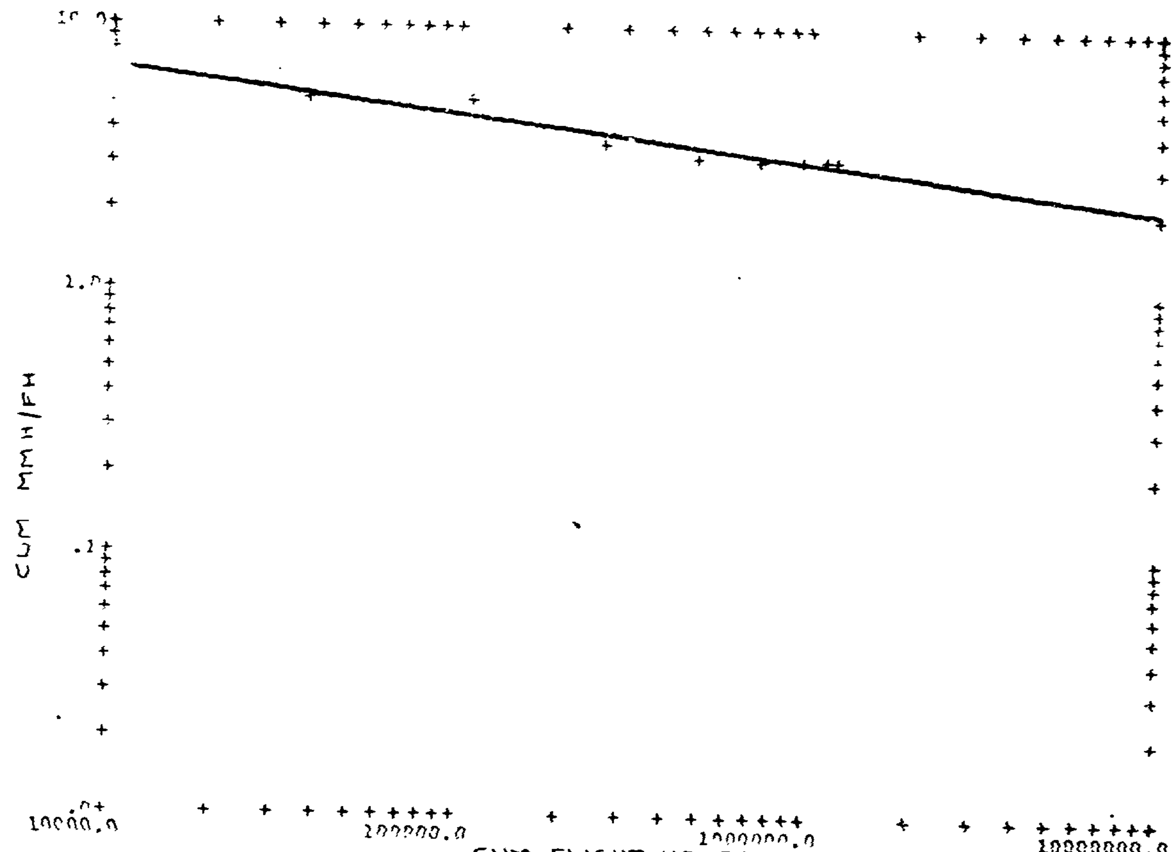
.101174 -.219697 12.856720 -2.727297 1.170329 .264579 -.971806

BETA ALPHA R

LANDING GEAR

CH-47 MMH/FH- CUM

FIGURE 23



3.510427	-.171783	12.856730	1.391952	1.1[illegible]33	.215229	-.9[illegible]4131
BETA	ALPHA					R

TOTAL

CH-47 MMH/FH- CUM

FIGURE 24

TABLE 2 - CH-47 SYSTEM REM GROWTH parameters

SYSTEM	MMH/FH - CUM*			MAL/FH - CUM		
	β	α	R	β	α	R
AIRFRAME	1.997	-.152	-.957	-1.915	.060	.704
POWER PLANT	-.127	-.017	-.157	-.766	-.048	-.539
FLIGHT CONTROL	2.631	-.295	-.971	2.010	-.315	-.965
ROTOR	-.714	-.005	-.088	-.957	-.120	-.897
INDICATING	.186	-.197	-.849	-1.619	-.073	-.849
EQUIPMENT	3.475	-.415	-.970	-.773	-.159	-.959
COMM/NAV	.883	-.268	-.931	-.068	-.224	-.907
HYDRAULIC	-.236	-.195	-.864	-1.456	-.142	-.958
LANDING GEAR	.101	-.220	-.972	-1.794	-.135	-.870
DRIVE	2.336	-.219	-.948	-3.939	.160	.951
ELECTRICAL	-.018	-.212	-.950	-.926	-.147	-.821
TOTAL	3.510	-.172	.934	1.044	-.063	-.884

* - ORGANIZATIONAL + Integrated Direct support, Direct maintenance manhours.

$\sigma_y = \sqrt{\dfrac{\sum_{i=1}^{n} (\ln x_i - \bar{x})^2}{m}}$

ASSUMED RELATIONSHIP

$\ln Y = \alpha \ln X + \beta$

ie $Y = e^{\beta} X^{\alpha}$

where

Y = cum malfunctions/flight hour

or Y = cum maintenance manhours/flight hour

and

X = cum flight hours

also

R = Correlation co-efficient

$\bar{X} = \ln \dfrac{\sum_{i=1}^{n} x_i}{m} = \sqrt[m]{\prod_{i=1}^{n} x_i}$

$\bar{Y} = \sqrt[m]{\prod_{i=1}^{n} y_i}$

$\sigma_x = \sqrt{\dfrac{\sum_{i=1}^{n} (\ln x_i - \bar{x})^2}{m}}$

	UH-1 ARMY			CUMULATIVE			CUM ARMY & NAVY FLT. HRS
CY	FLIGHT HOURS	NO. MAJOR ACCIDENTS	RATE/ 100,000 FH	FLIGHT HOURS	NO. MAJOR ACCIDENTS	RATE/ 100,000 FH	
1959	3,492	2	57.0	3,492	2	57.0	3492
1960	15,763	15	95.13	19,255	17	88.3	19255
1961	42,034	24	57.09	61,289	41	66.9	61289
1962	78,995	24	33.8[illegible]	132,284	65	49.13	132,284
1963	161,266	60	37.0[illegible]	293,550	125	42.58	293,691
1964	335,942	129	38.39	629,492	254	40.34	638,603
1965	[illegible]	162	[illegible]	1,222,731	416	[illegible]	1258807
1966	1,157,041	337	[illegible]	2,379,772	753	31.64	2462,376
1967	1,925,262	514	26.69	4,306,034	1,267	29.42	4460481
1968	2,538,903	490	19.29	6,844,937	1,757	25.66	7098615
1969	1,282,359	272	21.21	8,127,296	2,029	24.96	8431580
1970	2,687,434	481	17.89	10,814,730	2,510	23.20	11243384
1971	2,123,168	299	14.08	12,936,898	2,809	21.71	13493533
1972	1,266,471	136	10.73	14,203,369	2,945	20.73	14881088
1973	756,840	37	4.70	14,960,209	2,982	19.89	[illegible]

Dec → June →

USAAVS DATA | IDA DATA

TABLE 3- SAFETY GROWTH STATISTICS

UH-1 NAVY/USMC

CY	FLIGHT HOURS	NO. MAJOR ACCIDENTS	RATE/ 100,000 FH	CUMULATIVE FLIGHT HOURS	CUMULATIVE NO. MAJOR ACCIDENTS	CUMULATIVE RATE/ 100,000 FH	Cum Army and Navy Flight hours
1963	141	0	0	141	0	0	293691
1964	8,970	2	22.29	9,111	2	21.95	638603
1965	26,965	4	14.83	36,076	6	16.63	1258807
1966	46,528	7	15.03	82,604	13	15.73	2462376
1967	71,843	23	32.03	154,447	36	23.30	4460481
1968	99,231	24	24.21	253,678	60	23.65	7098615
1969	50606	15	37.54	~~304284~~	71	23.33	8431580
1970	128370	32	25.72	428654	103	24.03	11243384
1971	128031	23	17.96	556685	126	22.63	13493533
1972	121034	19	15.69	677719	145	21.40	14881088
1973	110322	4	3.62	788041	149	18.90	15778250

Dec

June

BELL UH1E

Utility/observation vehicle with 8-10 seats. Weighs 4750 pounds [illegible] 8500. Maximum speed 128 mph. Normal range [illegible] service ceiling is 16,700 feet. Hovering ceiling [illegible] Dimensions are 53 feet in length [illegible] 12.7 [illegible] height. Cargo capacity is 4000 [illegible] Lycoming T53-11 shaft turbine rated at 900 [illegible] of US Navy and Marine Corps. [illegible] Similar versions of the UH1E are the "L" models [illegible] upgraded [illegible] T53-13 engines. The Navy has [illegible] for use as advanced helicopter trainers and light [illegible] versions.

BELL UH1C (WITH 540 ROTOR)

Utility/observation vehicle with 8-10 seats. Weighs 5055 pounds empty and grosses 9500. Maximum speed 161 mph. Normal range is 203 miles and service ceiling is 21,000 feet. Hovering ceiling in ground effect is 15,800 feet. Dimensions are 53 feet in length, 8.3 feet in width and 12.6 feet in height. Cargo capacity is 4000 pounds. Has the Lycoming T53-11 shaft turbine rated at 900 hp with 550 of [illegible] Corps. REMARKS: [illegible] 1965

NOTE: INCLUDES ALL USMC UH-1E AND ALL NAVY UH-1 HELICOPTERS

TABLE 3-1

-2 NAVY

[illegible]	FLIGHT HOURS	NO. MAJOR ACCIDENTS	RATE/ 100,000 FH	CUMULATIVE FLIGHT HOURS	CUMULATIVE NO. MAJOR ACCIDENTS	CUMULATIVE RATE/ 100,000 FH
1961	2	0	0	2	0	0
1962	1,222	1	81.83	1,224	1	81.83
1963	14,889	12	80.59	16,113	13	80.68
1964	33,766	22	65.15	49,879	35	70.16
1965	37,200	13	34.94	87,079	48	55.12
1966	42,995	11	25.58	130,074	59	45.35
1967	40,827	9	22.04	170,901	68	39.78
1968	39,641	14	35.31	210,542	82	38.94
1969	18186	5	27.49	228728	87	38.04
1970	30753	5	16.26	259481	92	35.46
1971	27500	1	3.64	286981	93	32.41
1972	23560	4	16.98	310541	97	31.23
1973	26714	6	22.46	337255	103	31.43

FORMER NAVY DESIGNATION [illegible]

TABLE 3-2

-3 NAVY

CY	FLIGHT HOURS	NO. MAJOR ACCIDENTS	RATE/ 100,000 FH	CUMULATIVE FLIGHT HOURS	CUMULATIVE NO. MAJOR ACCIDENTS	CUMULATIVE RATE/ 100,000 FH
1958						
1959	UNK	1		UNK	1	
1960	UNK	2		UNK	3	
1961	[illegible]	[illegible]	9.11	[illegible]	[illegible]	[illegible]
1962	[illegible]	7	21.43	43,626	11	25.21
1963	[illegible]	[illegible]	13.65	[illegible]	20	[illegible]
1964	[illegible]	6	[illegible]	1[illegible]0,041	26	13.68
1965	[illegible]	[illegible]	[illegible]	[illegible]	33	11.93
1966	[illegible]	[illegible]	[illegible]	[illegible]	41	11.24
1967	[illegible]	13	[illegible]	[illegible]	54	11.81
1968	[illegible]	6	[illegible]	[illegible]	60	10.67
1969	49096	4	8.14	600683	64	10.65
1970	78067	10	12.81	678750	74	10.90
1971	69295	11	15.87	748045	85	11.36
1972	88538	6	6.78	836583	91	10.87
1973	95670	9	9.4	932253	100	10.73

NOTE: NAVY DESIGNATION ASS-2 APPLIES BEFORE 1960

FIG. 3-3

[illegible] ARMY				CUMULATIVE		
[illegible]	[illegible]	[illegible] ACCIDENTS	[illegible] 100,000 FH	FLIGHT HOURS	NO. MAJOR ACCIDENTS	RATE/ 100,000 FH
[illegible]	[illegible]	[illegible]	[illegible]	228	0	0
[illegible]	[illegible]	13	[illegible]	19,[illegible]	13	66.00
[illegible]	[illegible]	[illegible]7	5[illegible]	239,512	140	58.50
1969	[illegible]	[illegible]	49.83	446,[illegible]	242	54.45
1970	[illegible]	193	42.46	906,661	426	48.40
1971	[illegible],935	163	35.77	[illegible]	[illegible]	45.34
1972	13[illegible],303	48	36.83	1,[illegible],907	582	44.56
[illegible]	25,794	12	46.5[illegible]	[illegible]	5[illegible]	44.54

[illegible]

TABLE 3-4

	H-19 NAVY			CUMULATIVE			
CY	FLIGHT HOURS	NO. MAJOR ACCIDENTS	RATE/ 100,000 FH	FLIGHT HOURS	NO. MAJOR ACCIDENTS	RATE/ 100,000 FH	CUM ARMY + NAVY
* 1952	35,116	18	51.25	35,116	18	51.25	35,116
Dec 1953	65,266	62	94.99	100,382	80	79.69	100,382
1954	68,041	42	61.72	168,423	122	72.43	168,423
1955	66,898	40	59.79	235,321	162	68.84	135,321
1956	64,912	28	43.13	300,233	190	63.28	300,233
1957	59,975	31	51.68	360,208	221	61.35	360,
1958	56,102	26	46.34	416,310	247	59.33	462,006
1959	47,[illegible]	18	[illegible]	[illegible]	265	57.1[illegible]	561,110
1960	[illegible]	13	29.37	5[illegible]7,911	278	54.73	667,935
1961	34,014	5	17.63	541,925	284	52.4[illegible]	760,768
1962	33,132	6	17.9[illegible]	575,357	290	50.00	859,737
1963	24,313	9	38.[illegible]	[illegible]	299	49.9[illegible]	940,228
1964	15,[illegible]	1	6.[illegible]	61[illegible],682	300	[illegible]	1,032,567
1965	5,[illegible]	2	34.74	619,438	302	48.75	1,117,650
1966	[illegible]	3	39.1	[illegible]	305	[illegible]	1,133,532
1967	4,713	1	20.9	631,806	306	[illegible]	1,146,634
1968	1,[illegible]	0	0	633,436	306	48.31	1,150,702

*H-19 Includes 11 H-19E (Hrs.) and H-19[illegible] [illegible] Experience

Data Prior to 1952 Not Available

TABLE 7

	H-19 ARMY			CUMULATIVE			
FY	FLIGHT HOURS	NO. MAJOR ACCIDENTS	RATE/ 100,000 FH	FLIGHT HOURS	NO. MAJOR ACCIDENTS	RATE/ 100,000 FH	
1958	45,696	27	59.1[illegible]	45,696	27	59.08	442,006
1959	52,061	22	42.2[illegible]	97,757	49	50.12	561,110
1960	62,137	26	41.7[illegible]	[illegible]	75	46.86	667,935
1961	[illegible]	19	30.[illegible]	218,8[illegible]	93	42.49	760,768
1962	65,537	17	25.93	284,38[illegible]	110	38.68	859,737
1963	57,178	18	31.4[illegible]	341,[illegible]	128	37.47	900,278
1964	77,[illegible]	15	19.[illegible]	418,866	143	34.13	1,032,567
1965	[illegible]	[illegible]	[illegible]	[illegible]	151	31.31	1,117,650
1966	[illegible]	2	24.36	[illegible]	153	30.21	1,133,532
1967	8,119	1	12.0[illegible]	514,738	154	29.91	1,146,634
1968	2,52[illegible]	0	[illegible]	517,264	154	29.77	1,150,702

Data Prior to 1958 Not Available

TABLE 3-6

	H-21 A/B USAF			CUMULATIVE			CUM ARMY & AIRFORCE HRS
CY	FLIGHT HOURS	NO. MAJOR ACCIDENTS	RATE/ 100,000 FH	FLIGHT HOURS	NO. MAJOR ACCIDENTS	RATE/ 100,000 FH	
1953	1,109	1	90.17	1,109	1	90.17	1,109
1954	1,537	1	[illegible]	2,646	2	75.58	4,403
1955	[illegible],423	7	[illegible]	13,069	9	68.86	26,493
1956	[illegible]	11	44.32	37,554	20	53.25	70,772
1957	[illegible]	12	[illegible]	73,642	32	43.45	152,895
1958	[illegible]	14	[illegible]	115,269	46	39.93	267,913
1959	[illegible]	15	[illegible]	157,335	61	[illegible].77	379,011
1960	[illegible]	5	[illegible]	[illegible]	66	35.48	476,764
1961	[illegible]	7	[illegible]	212,762	73	34.3[illegible]	577,370
1962	[illegible]	[illegible]	[illegible]	236,629	79	33.37	669,357
1963	[illegible]	5	[illegible]	258,153	84	32.53	754,213
1964	[illegible]	2	[illegible]	278,132	86	30.92	810,361
1965	[illegible]	0	0	293,674	86	29.28	850,579
1966	[illegible]	0	0	[illegible],008	86	28.[illegible]	871,132
1967	[illegible]	0	0	317,727	86	27.[illegible]	900,974
1968	[illegible]	3	[illegible]	[illegible]	89	27.[illegible]	922,625

TABLE [illegible]

	F-21C ARMY			CUMULATIVE			Cum
CY	FLIGHT HOURS	NO. MAJOR ACCIDENTS	RATE/ 100,000 FH	FLIGHT HOURS	NO. MAJOR ACCIDENTS	RATE/ 100,000 FH	ARMY & AIRFORCE HRS
1954	[illegible]	0	0	1,757	0	0	4,403
1955	[illegible]	4	[illegible]	13,424	4	29.81	26,483
1956	[illegible]	8	[illegible]	32,218	12	36.12	70,772
1957	46,135	20	43.46	[illegible]	32	[illegible]	152,895
1958	[illegible]	32	[illegible]	[illegible]	84	55.03	263,913
1959	[illegible]	[illegible]	62.77	[illegible]	126	52.6[illegible]	379,911
1960	68,596	22	31.67	293,272	150	51.67	476,264
1961	[illegible]	35	[illegible]	[illegible]	185	50.73	577,370
1962	[illegible]	38	[illegible]	[illegible]	223	50.85	669351
1963	[illegible]	51	33.10	[illegible]	271	54.63	754,213
1964	[illegible]	17	45.9	533,229	288	54.11	810,361
1965	[illegible]	10	42.34	555,695	298	53.53	850,579
1966	[illegible]	3	21.05	571,124	301	52.70	871,132
1967	12, 33	7	57.59	583.257	308	52.80	900,974
1968	[illegible]	2	18.23	593,821	310	52.20	922,625

TABLE 3-8

H-34 ARMY

CY	FLIGHT HOURS	NO. MAJOR ACCIDENTS	RATE/ 100,000 FH	CUMULATIVE FLIGHT HOURS	CUMULATIVE NO. MAJOR ACCIDENTS	CUMULATIVE RATE/ 100,000 FH	Cum Army & Navy Flt Hrs
* [illegible]	[illegible]	45	53.66	37,836	45	53.66	260,137
Dec 19[illegible]	[illegible]	[illegible]	29.75	[illegible]	76	[illegible]	487,296
[illegible]	[illegible]	[illegible]	16.04	[illegible]	[illegible]	[illegible]	762,[illegible]80
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	107	[illegible]	1063364
[illegible]62	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	25.37	1381490
1963	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1699211
1964	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2,014,790
196[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2322630
1966	[illegible]	4	[illegible]	[illegible]	[illegible]	[illegible]	261[illegible]307
196[illegible]	[illegible]	6	[illegible]	[illegible]	174	[illegible]	2,861,777
[illegible]	[illegible]	7	[illegible]	[illegible]	181	[illegible]	3067,207

[illegible] NOT AVAILABLE

TAB [illegible]

CY	FLIGHT HOURS	NO. MAJOR ACCIDENTS	RATE/ 100,000 FH	CUMULATIVE FLIGHT HOURS	CUMULATIVE NO. MAJOR ACCIDENTS	CUMULATIVE RATE/ 100,000 FH	[illegible]
1955	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3780
1956	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	26983
1957	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	74640
1958	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	31.[illegible]	[illegible]
1959	[illegible]	[illegible]	[illegible]	[illegible]	82	[illegible]	[illegible]
1960	[illegible]	27	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1961	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1962	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1963	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1964	[illegible]	[illegible]	[illegible]	[illegible]	217	[illegible]	[illegible]
1965	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1966	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2614307
1967	[illegible]	[illegible]	[illegible]	[illegible]	338	[illegible]	[illegible]
1968	[illegible]	22	[illegible]	[illegible]	360	[illegible]	3067209

NOTE - [illegible] DATA ON [illegible]

TABLE 3-10

H-37 (NAVY)

CY	FLIGHT HOURS	NO. MAJOR ACCIDENTS	RATE/ 100,000 FH	CUMULATIVE FLIGHT HOURS	CUMULATIVE NO. MAJOR ACCIDENTS	CUMULATIVE RATE/ 100,000 FH	Cum Army & Navy Flt Hrs
1955	0	0	0	0	0	0	
1956	197	0	0	197	0	0	
1957	2,828	3	106.08	3,025	3	99.17	
1958	7,171	8	111.56	10,196	11	107.88	16 360
1959	10,750	5	46.51	20,946	16	76.38	37594
1960	9,038	3	33.19	29,984	19	63.36	60 697
1961	10,695	1	9.35	40,679	20	49.18	85577
1962	6,672	2	29.96	47,351	22	46.37	106,953
1963	8,258	1	12.10	57,609	23	39.92	131,824
1964	8,074	3	37.15	65,683	26	39.58	155,904
1965	6,055	0	0	71,738	26	36.24	173926
1966	4,352	0	0	76,090	26	34.17	185379
1967	1,527	0	0	77,617	26	33.49	193,342
1968	0	0	0	77,617	26	33.49	198,864

NOTE: NAVY DESIGNATION HR2S APPLIES BEFORE 1962.

TABLE 3-11

CH-37 (ARMY)

CY	FLIGHT HOURS	NO. MAJOR ACCIDENTS	RATE/ 100,000 FH	CUMULATIVE FLIGHT HOURS	CUMULATIVE NO. MAJOR ACCIDENTS	CUMULATIVE RATE/ 100,000 FH	[illegible]
1955							
1956							
1957							
[illegible]	6,164	3	[illegible]	6,164	3	48.66	16360
[illegible]	[illegible]	3	[illegible]	16,548	6	36.25	[illegible]
[illegible]	[illegible]	3	[illegible]	30,713	9	29.30	[illegible]
[illegible]	[illegible]	3	[illegible]	[illegible]	12	26.72	[illegible]
1962	[illegible]	6	[illegible]	[illegible]	18	31.24	[illegible]
1963	[illegible]	7	[illegible]	[illegible]	25	33.69	[illegible]
[illegible]	[illegible]	6	[illegible]	90,223	31	34.36	155904
1965	11,967	1	8.35	102,188	32	31.31	173926
1966	[illegible]	0	0	109,309	32	29.22	185397
1967	6,416	1	[illegible]	115,725	33	28.51	193342
968	5,542	1	[illegible]	121,267	34	28.03	[illegible]
1969	2 670	2	74.90	· 123937	36	29.04	201654
1970	2485	0	0.00	126422	36	28.48	204839
1971	352	0	0.00	126779	36	28.40	204391

* DATA PRIOR TO 1958 NOT AVAILABLE.

TABLE 3-12

UH/CH-46 ALL MODELS

CY	FLIGHT HOURS	NO. MAJOR ACCIDENTS *	RATE/ 100,000 FH	CUMULATIVE FLIGHT HOURS	CUMULATIVE NO. MAJOR ACCIDENTS *	CUMULATIVE RATE/ 100,000 FH
1961						
1962						
1963	125	0	0	~~[illegible]~~ 125	~~125~~ 0	0
1964	3,345	1	29.89	~~1~~ 3,470	~~3,470~~ 1	28.81
[illegible]	19,555	0	0	~~1~~ 23,0[illegible]	~~23,025~~ 1	4.34
19[illegible]	[illegible]	8	1[illegible].33	~~[illegible]~~ [illegible]	~~70,533~~ 9	12.75
1[illegible]	[illegible]	22	2[illegible].13	~~[illegible]~~ 1[illegible]	~~146,042~~ 31	21.22
19[illegible]	1[illegible],7[illegible]	25	17.6[illegible]	~~[illegible]~~ [illegible]	~~287,606~~ 56	19.45
1969	[illegible]	26	1[illegible].82	~~[illegible]~~ [illegible],359	~~442,359~~ 82	18.53
1970	155,751 ~~[illegible]~~	~~12~~ 17	12.25 ~~11.91~~	[illegible]541,110	~~543,072~~ 99	17.03 ~~17.30~~
1971	109,750	11	10.02	690,560	110	15.92
1972	[illegible]	4	4.18	786,460	114	14.49
1973	[illegible]	7	5.22	8[illegible],460	121	13.58

* EXCLUDES GROUND ACCIDENTS

TABLE 3-13

Best Available Copy

				CUMULATIVE		
CY	FLIGHT HOURS	NO. MAJOR ACCIDENTS *	RATE/ 100,000 FH	FLIGHT HOURS	NO. MAJOR ACCIDENTS *	RATE/ 100,000 FH
1961	[illegible]	0	0.00	[illegible]	0	0.00
1962	[illegible]	0	0.00	[illegible]	0	0.00
1963	[illegible]	1	21.04	[illegible]	1	7.02
1964	[illegible]	4	36.31	[illegible]	5	29.64
1965	[illegible]	[illegible]	[illegible]	37,[illegible]	11	29.73
1966	[illegible]	[illegible]	[illegible]	[illegible],340	25	23.07
1967	[illegible],3[illegible]	[illegible]	6.[illegible]	25[illegible]	[illegible]5	[illegible]
1968	[illegible]	[illegible]	11.84	47[illegible]	61	[illegible]
1969	[illegible]	[illegible]	[illegible].77	72[illegible]	[illegible]5	[illegible]
1970	[illegible]	24	[illegible]	93[illegible]	104	11.32
1971	[illegible]	18	[illegible]	1,12[illegible]	[illegible]	[illegible]
1972	[illegible]	2	[illegible].64	1,196,200	129	[illegible]
1973	[illegible]	1	[illegible]	1,2[illegible]	130	[illegible].42

* excludes ground accidents

TABLE 3-14

	CH-53 USMC			CUMULATIVE		
CY	FLIGHT HOURS	NO. MAJOR ACCIDENTS	RATE/ 100,000 FH	FLIGHT HOURS	NO. MAJOR ACCIDENTS	RATE/ 100,000 FH
[illegible]	2,753	1	[illegible]	2,753	1	36.30
1967	18,770	2	[illegible]	21,523	3	13.93
[illegible]	[illegible]	10	[illegible]	51,396	13	25.29
[illegible]	[illegible]	8	[illegible]	92,208	21	23.27
1970	20126	2	9.94	110334	23	20.85
1971	43798	6	13.70	154132	29	18.88
1972	46714	4	8.56	200846	33	16.43
1973	43969	11	25.02	244815	44	17.97

TA[illegible] 15

CY	CH-54 [illegible]			CUMULATIVE		
	[illegible]	NO. MAJOR ACCIDENTS	RATE/ 100,000 FH	FLIGHT HOURS	NO. MAJOR ACCIDENTS	RATE/ 100,000 FH
1965	[illegible]	[illegible]	[illegible]	1,[illegible]	0	0
19[illegible]	[illegible]	[illegible]	1[illegible].90	2,711	2	73.77
1967	[illegible]	[illegible]	[illegible].40	7,216	4	55.[illegible]
19[illegible]	[illegible]	2	13.[illegible]	22,[illegible]	6	26.[illegible]
[illegible]	9,510	2	[illegible]	[illegible]	[illegible]	[illegible]16
1970	[illegible]	2	[illegible]	[illegible]	1[illegible]	[illegible]
1971	[illegible]	2	[illegible]	[illegible]	[illegible]	1[illegible].5[illegible]
1972	[illegible]	2	[illegible]	[illegible]	[illegible]	[illegible]
1973	[illegible]	1	[illegible]	[illegible]	[illegible]	17.66

Dec

June

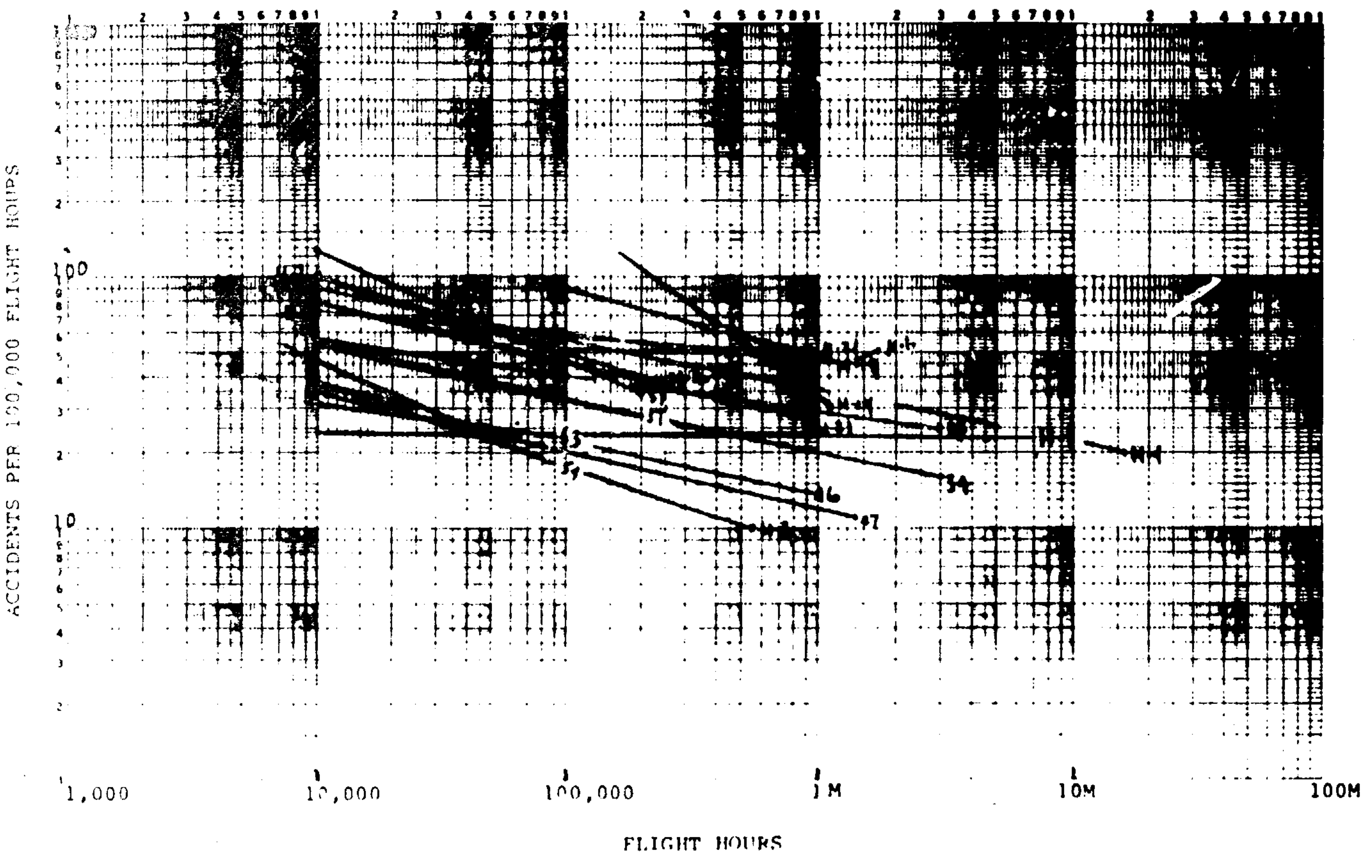
IDA DATA

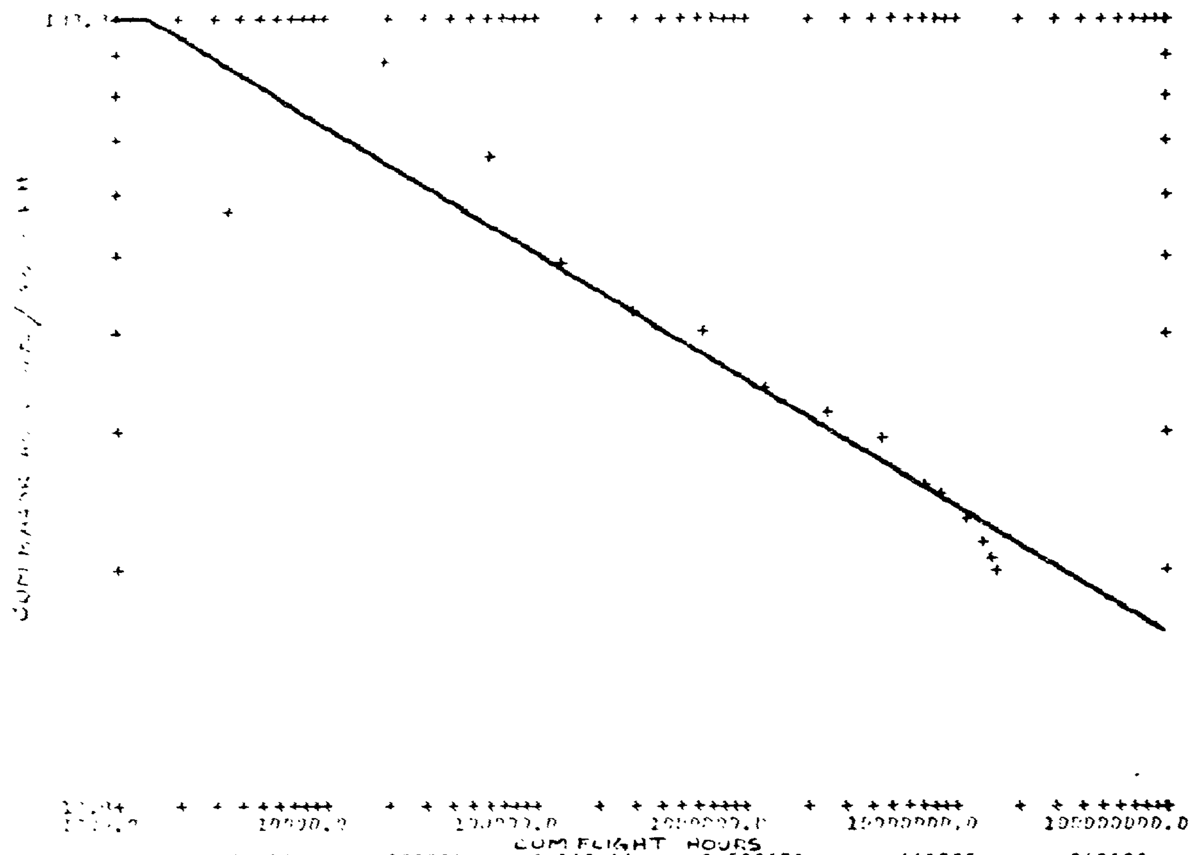
TABLE 3-16

FIGURE 25 - COMPOSITE SAFETY GROWTH CURVES

CUM RATE

ARMY
NAVY/AIR FORCE



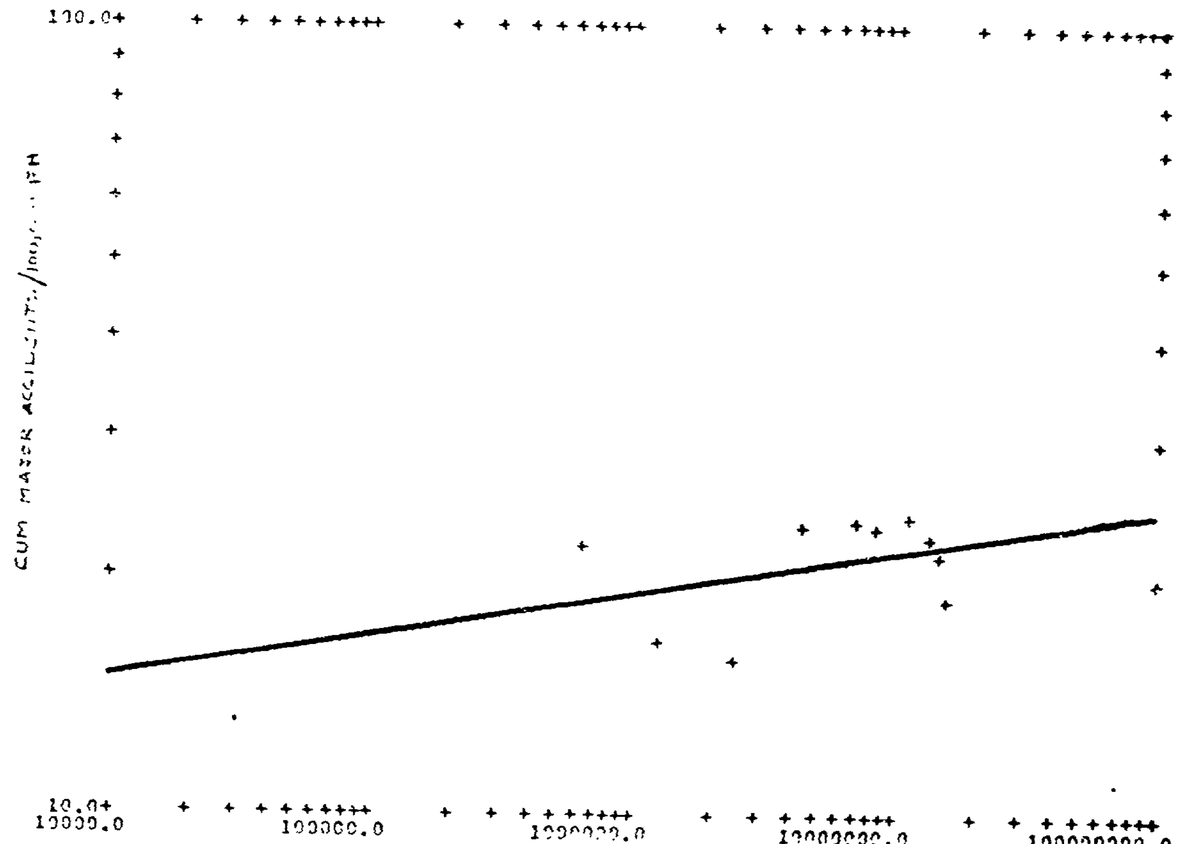


3.775315 -.160752 1.989758 3.562611 2.593679 .441795 -.940103

BETA ALPHA R

UH-1 ARMY

FIGURE 26

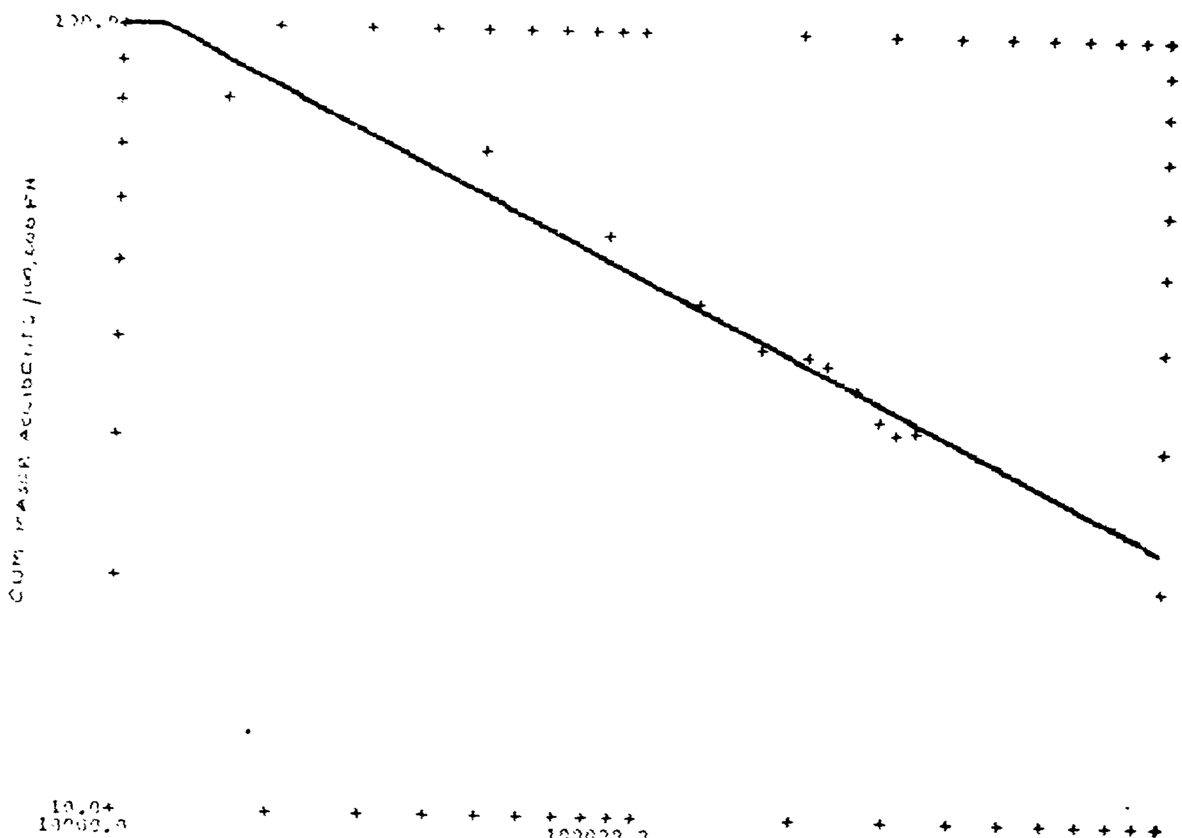


2.202024 .054214 15.498577 3.041893 1.056284 .165265 .394213

BETA ALPHA R

UH-1 NAVY/USMC

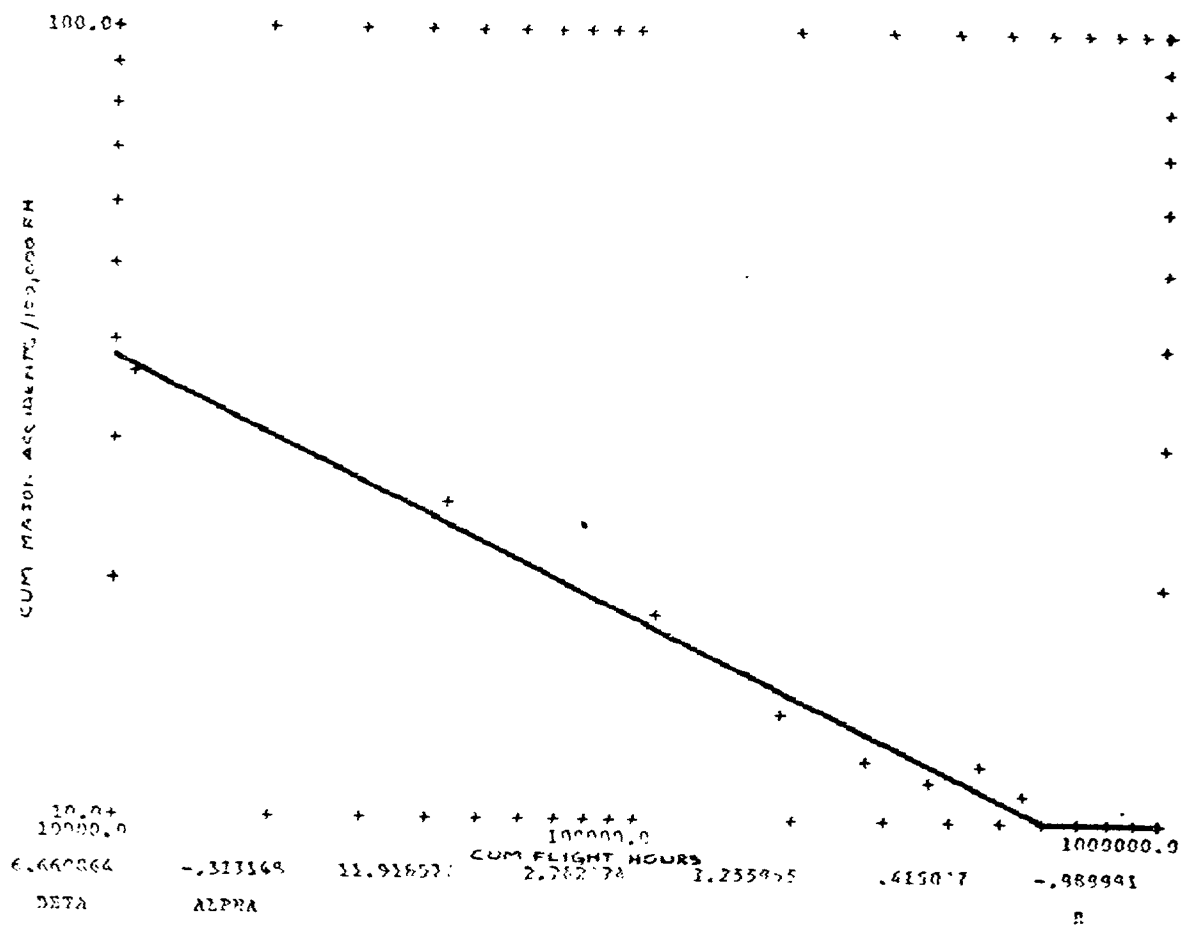
FIGURE 27



7.736153	-.339472	11.882728	3.762793	.809787	.308749	-.976265
BETA	ALPHA					R

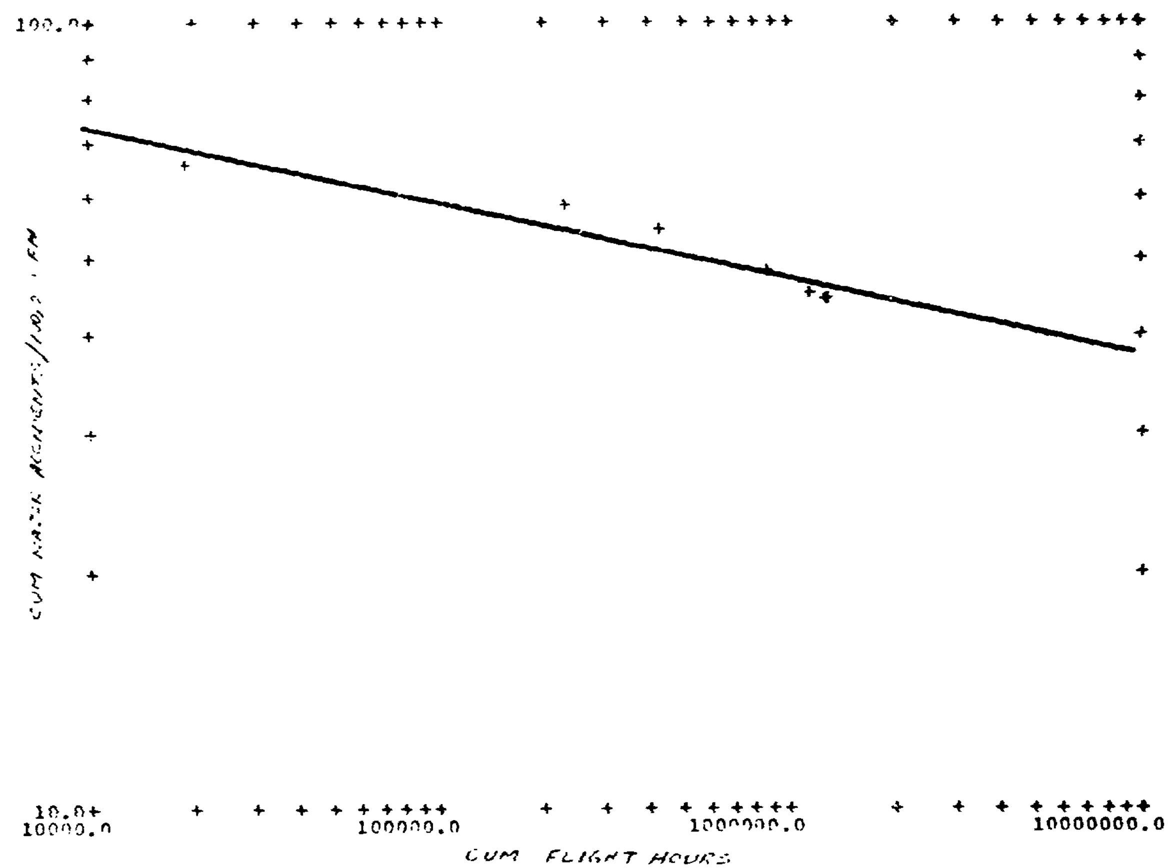
H-2 NAVY

FIGURE 28



H- NAVY

FIGURE 29

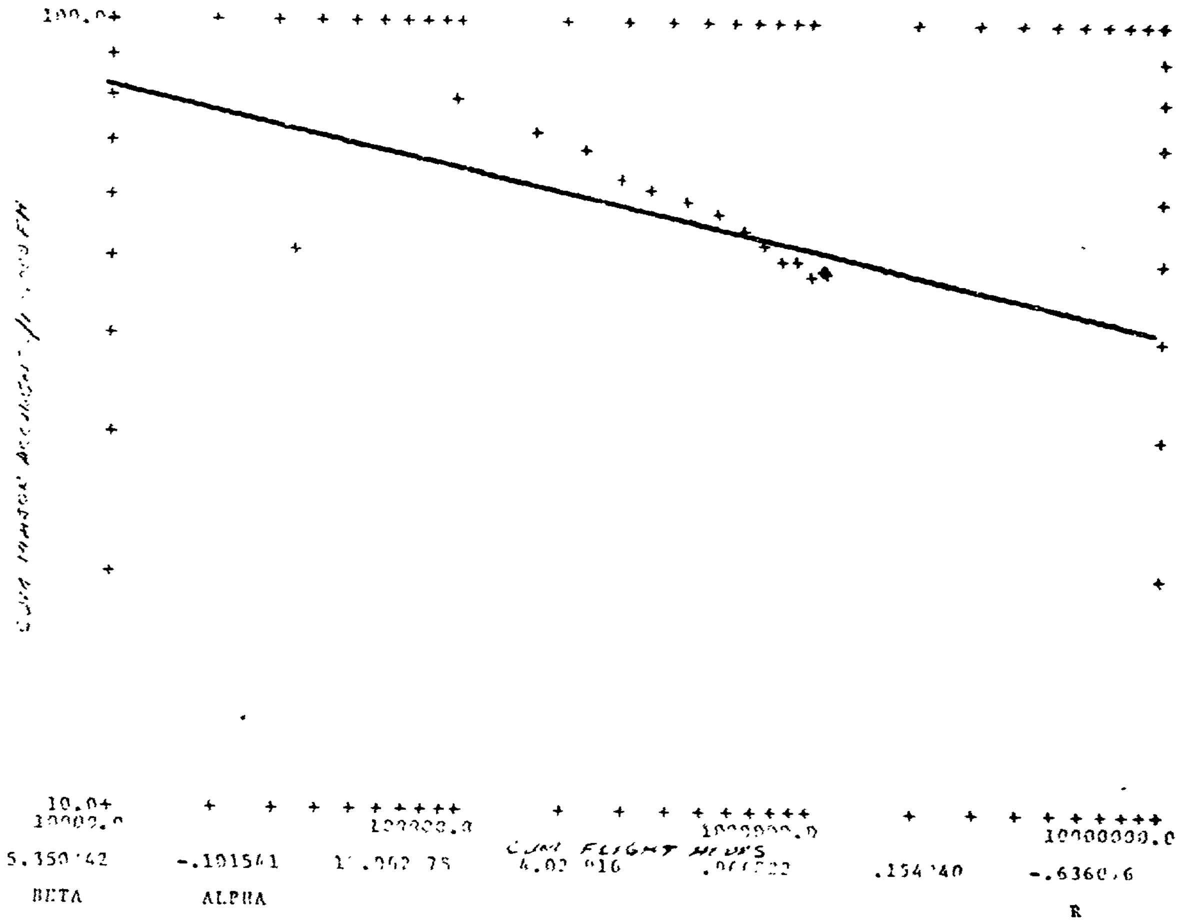


5.134950 -.095995 12.827099 3.934504 1.411412 .142960 -.947732

BETA ALPHA R

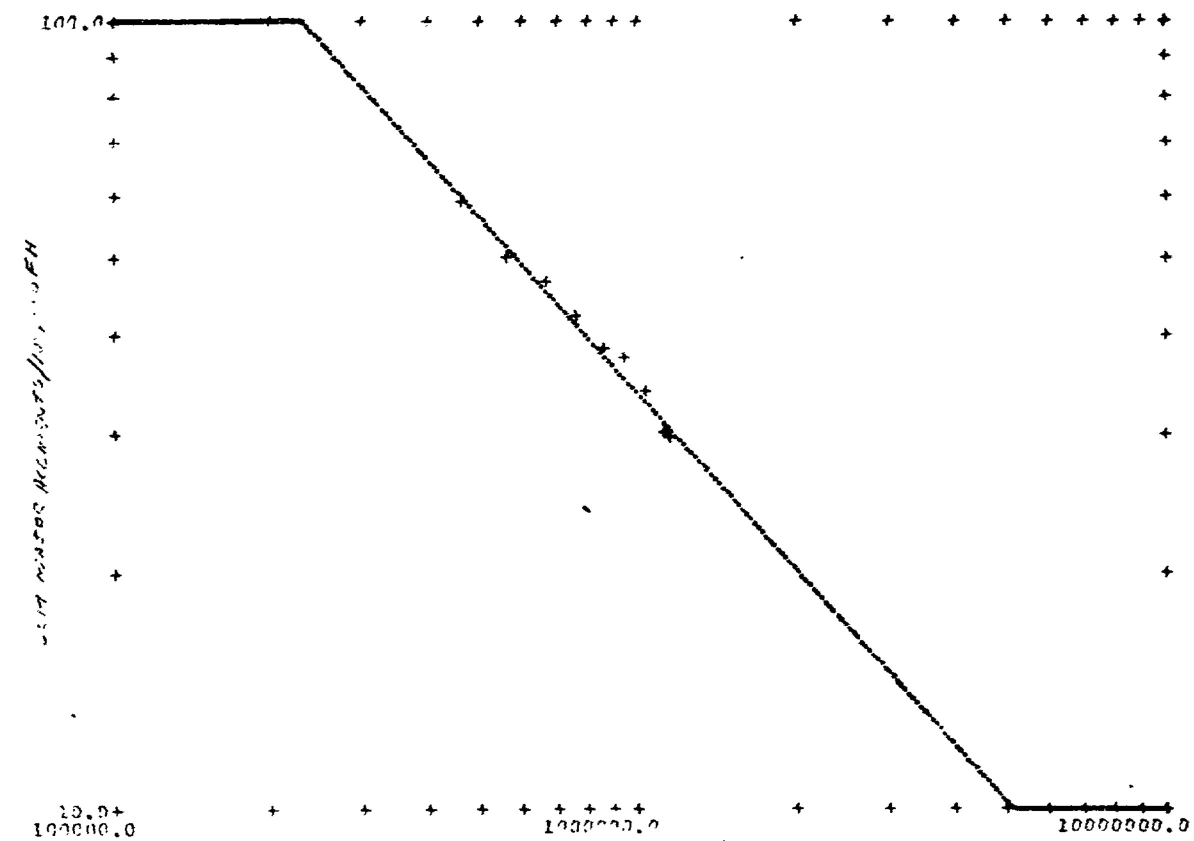
OH-6 AR Y

FIGURE 30



H-1? NAVY

FIGURE 31

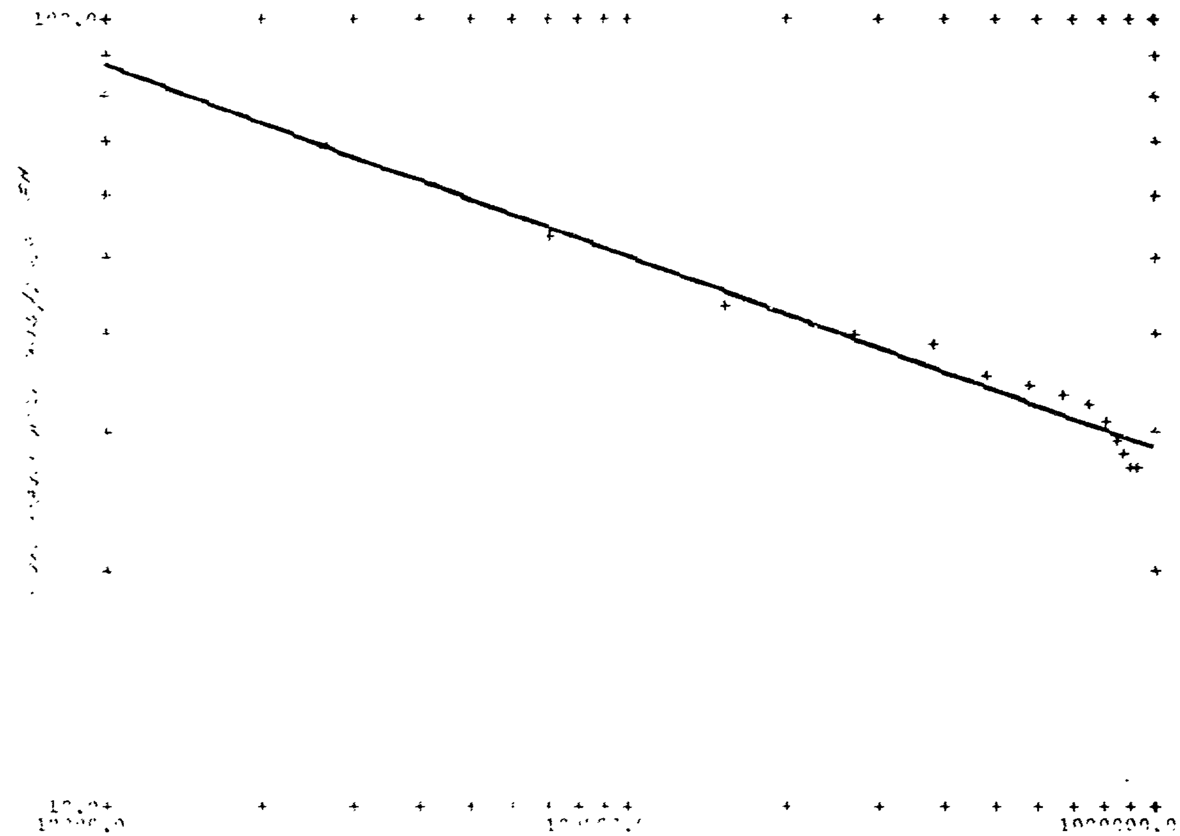


13.7?1555 -.741?1? 1?.601515 3.637254 .?1676 .225355 -.991281

BETA ALPHA R

H-1? ARMY

FIGURE 32



-.242552

ALPHA

R

FIGURE 33

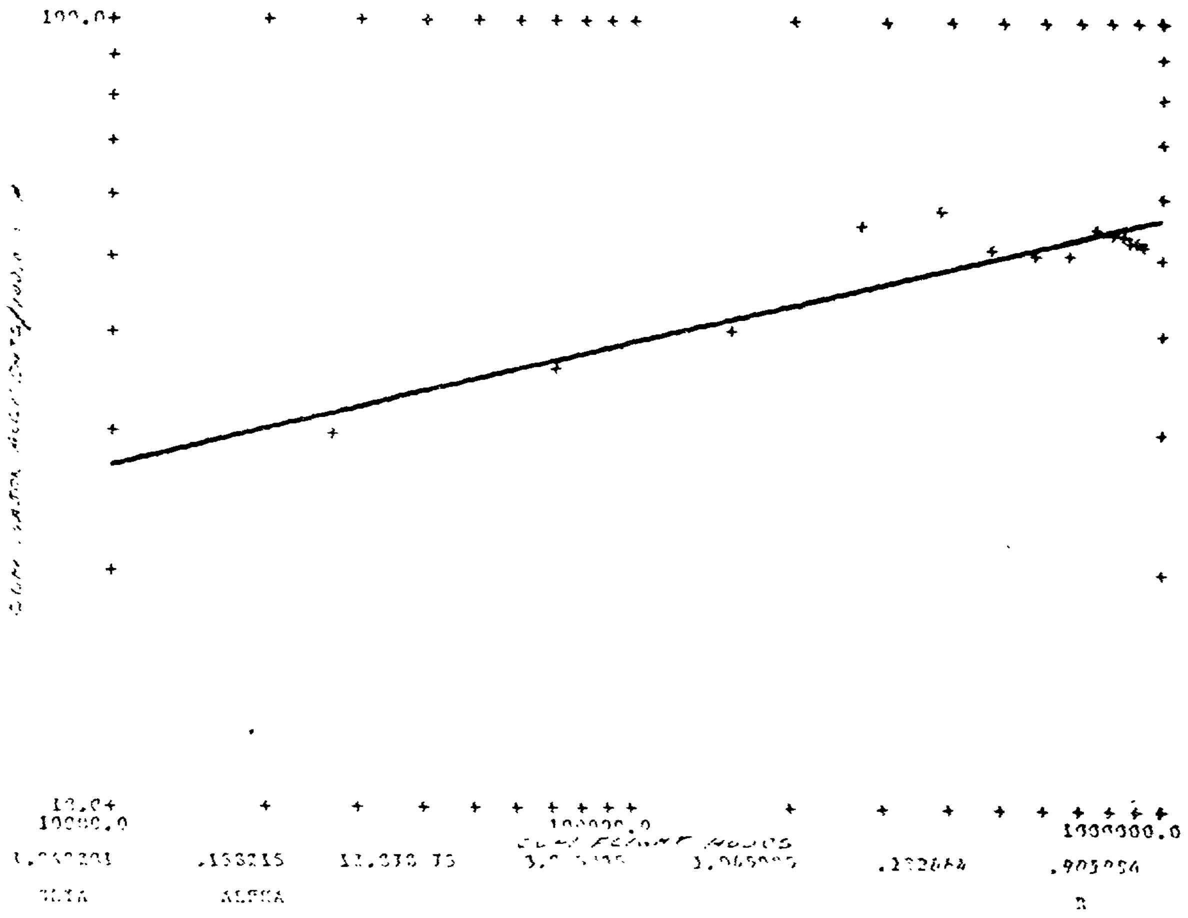
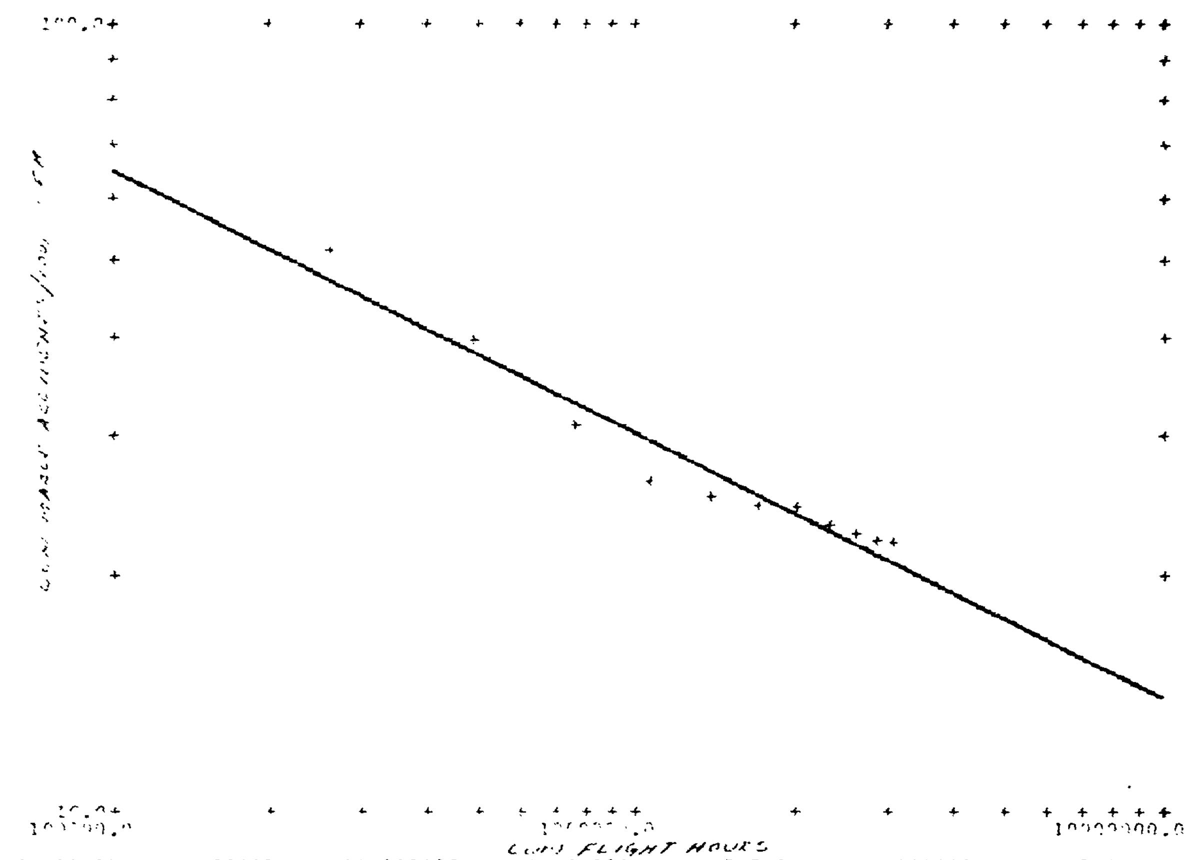


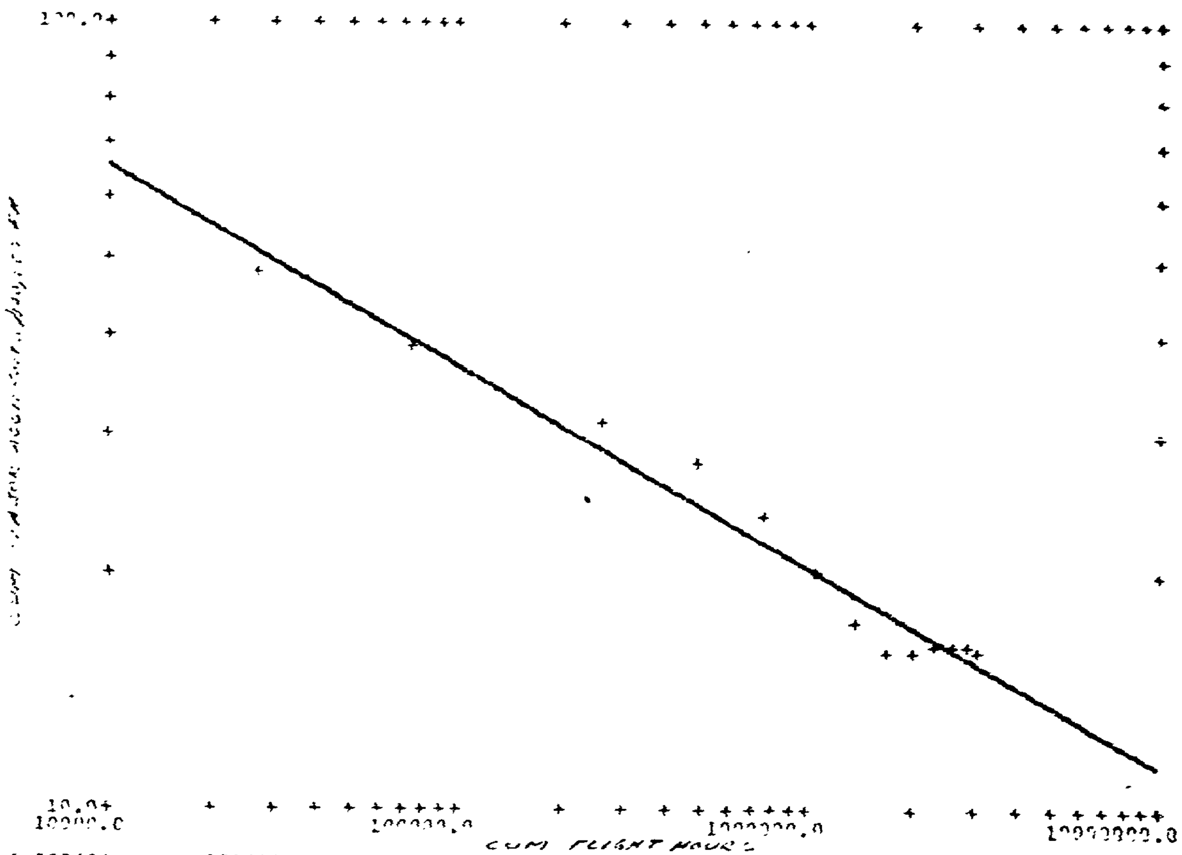
FIGURE 34



-.334617 14.111433 -.972679

BETA ALPHA R

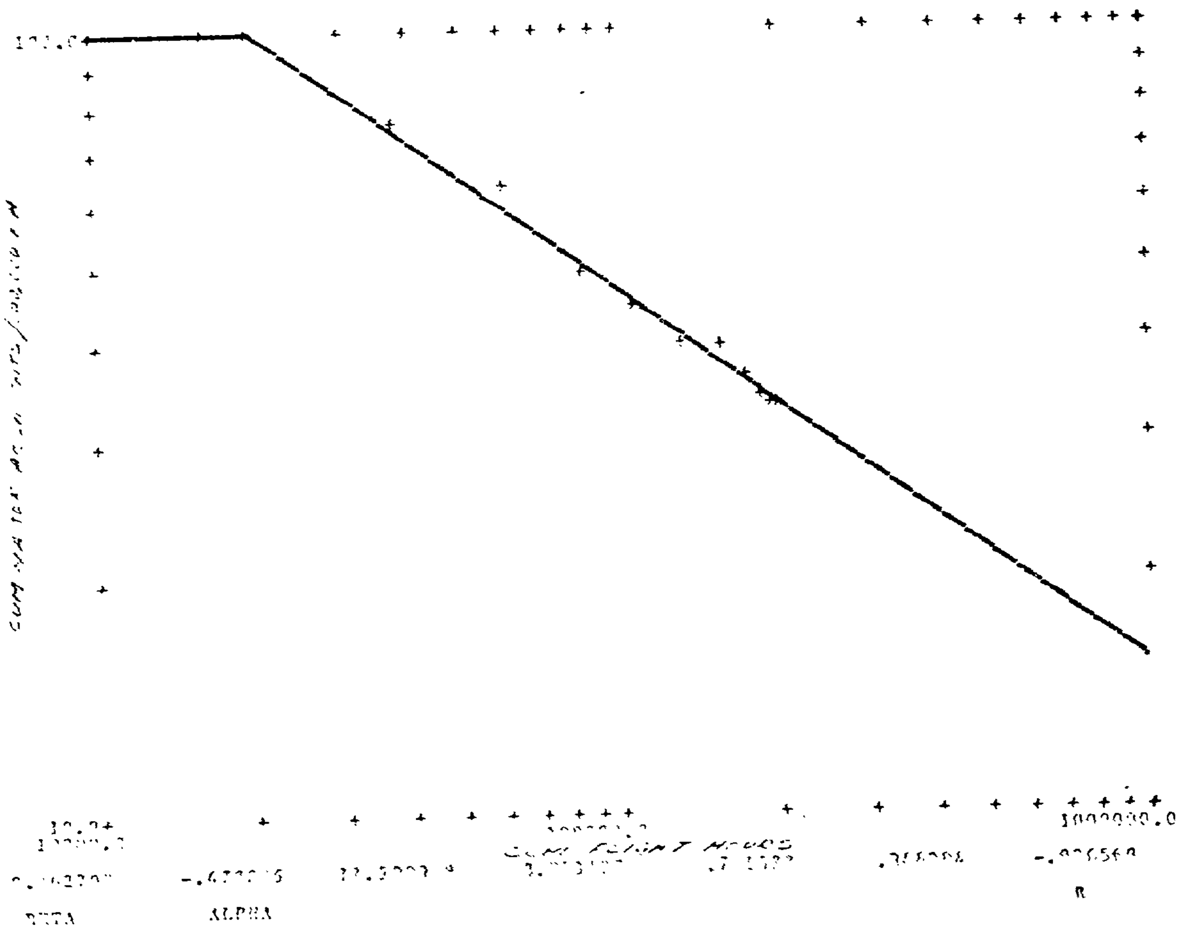
FIGURE 35



6.527604	-.257944	1?.58?1?3	?.976?13	1.4?6?5?	.36?159	-.9?2?22
BETA	ALPHA					R

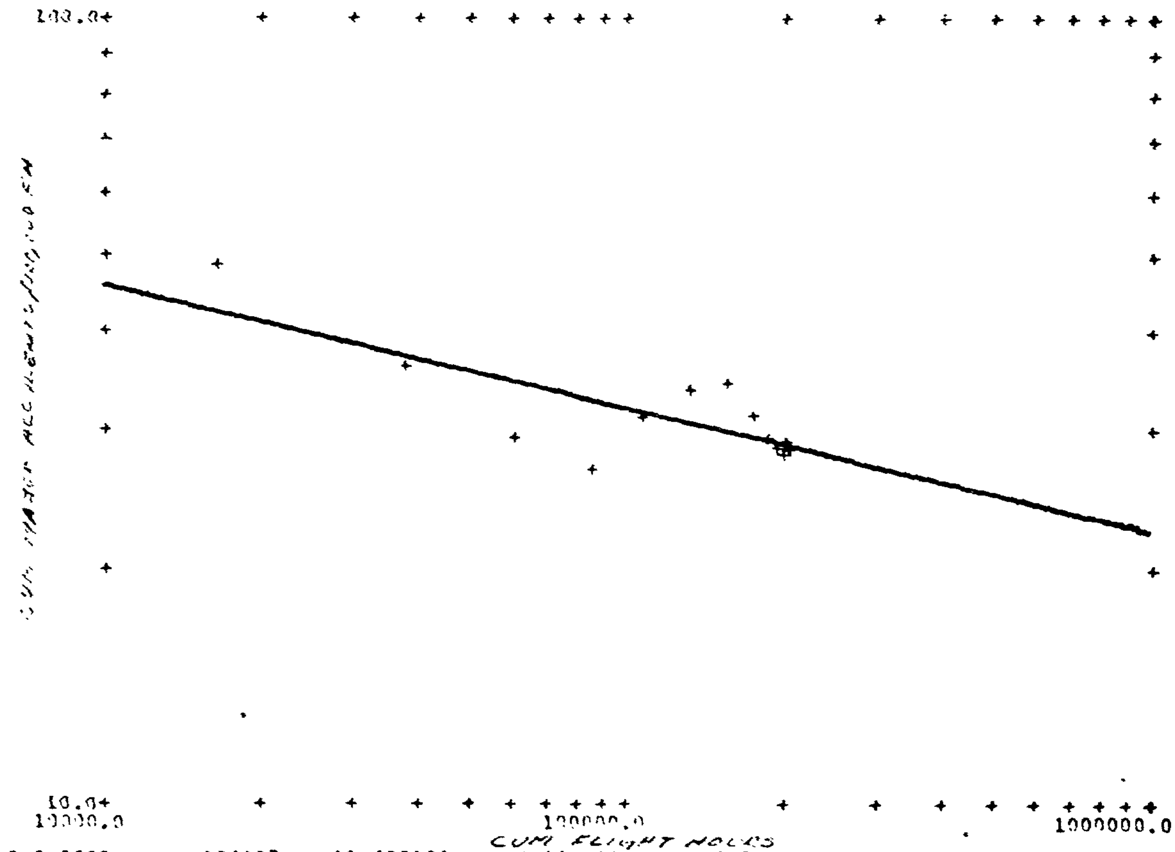
H-34 NAVY/ S C

FIGURE 36



H- 7 NAVY

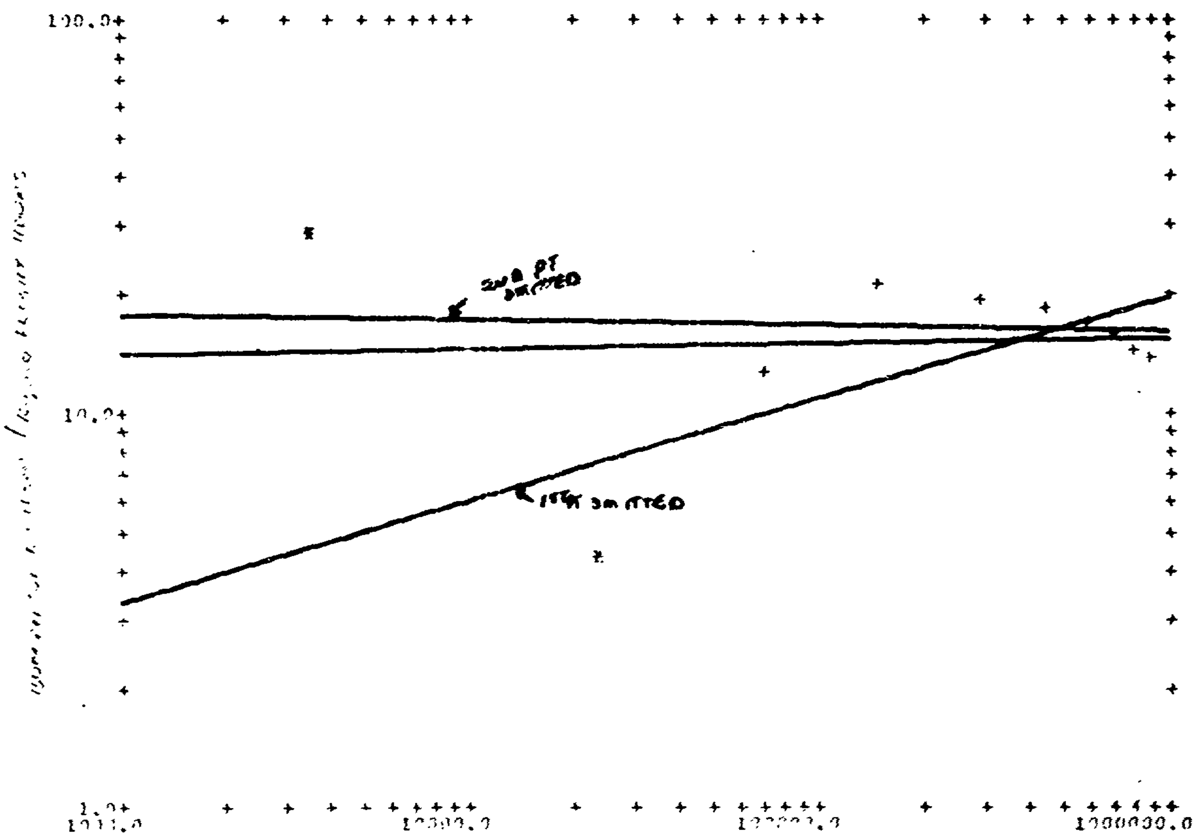
FIGURE 37



5.295953	-.156407	11.655104	3.44 ...	.737219	.148593	-.776028
DELTA	ALPHA					R

CH-37 ARMY

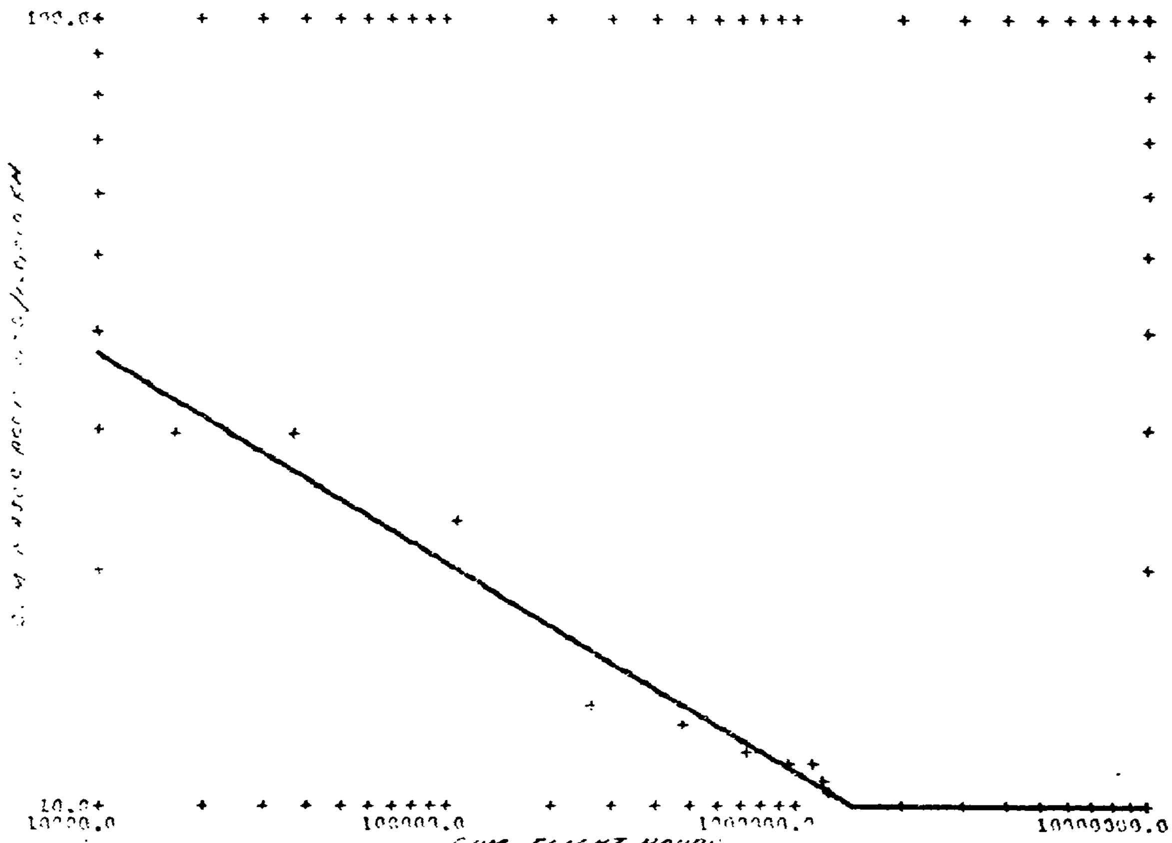
FIGURE 38



2.035060 -.014487 12.626635 2.799271 .036023 .165532 -.073231 - Parameters for two point omitted model

BETA ALPHA R

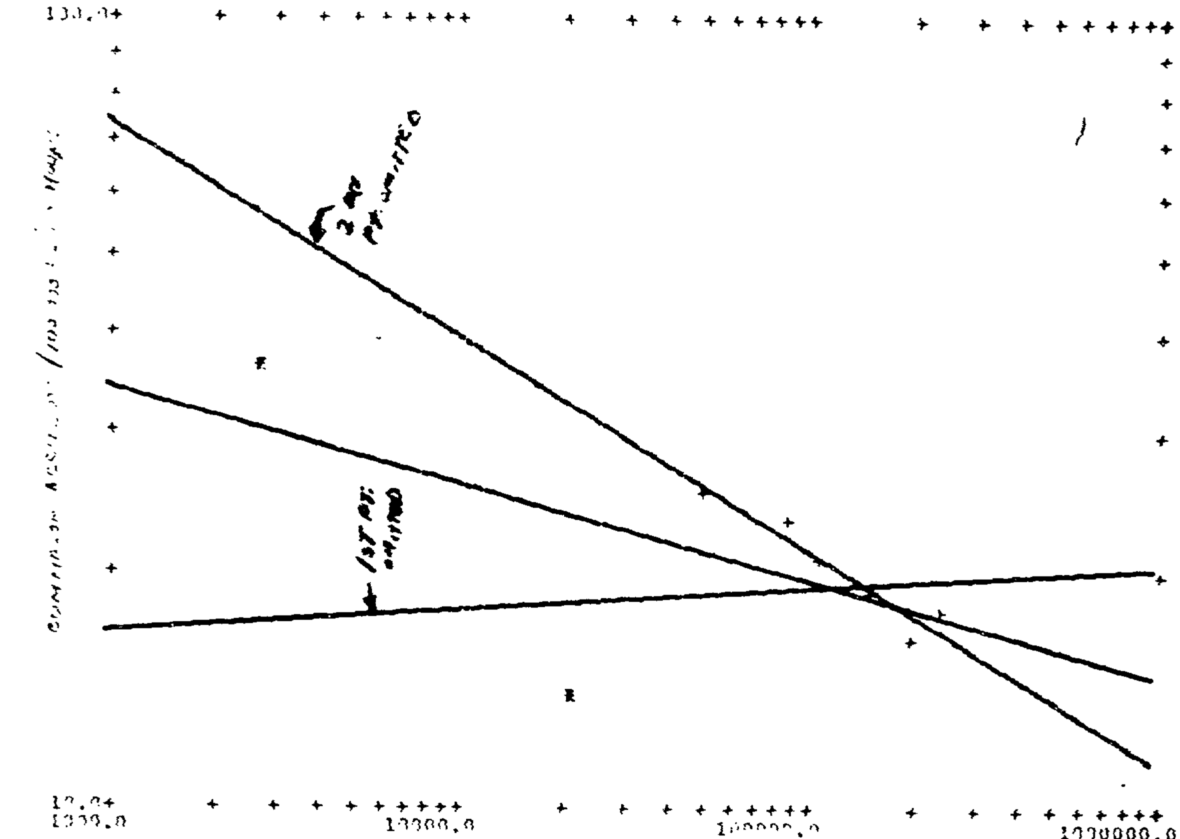
FIGURE 39



6.07[illegible]	-.266042	12.662[illegible]	2.10[illegible]	1.67[illegible]	.693815	-.975997
BETA	ALPHA					R

CH-47 ALL MODELS

FIGURE 40

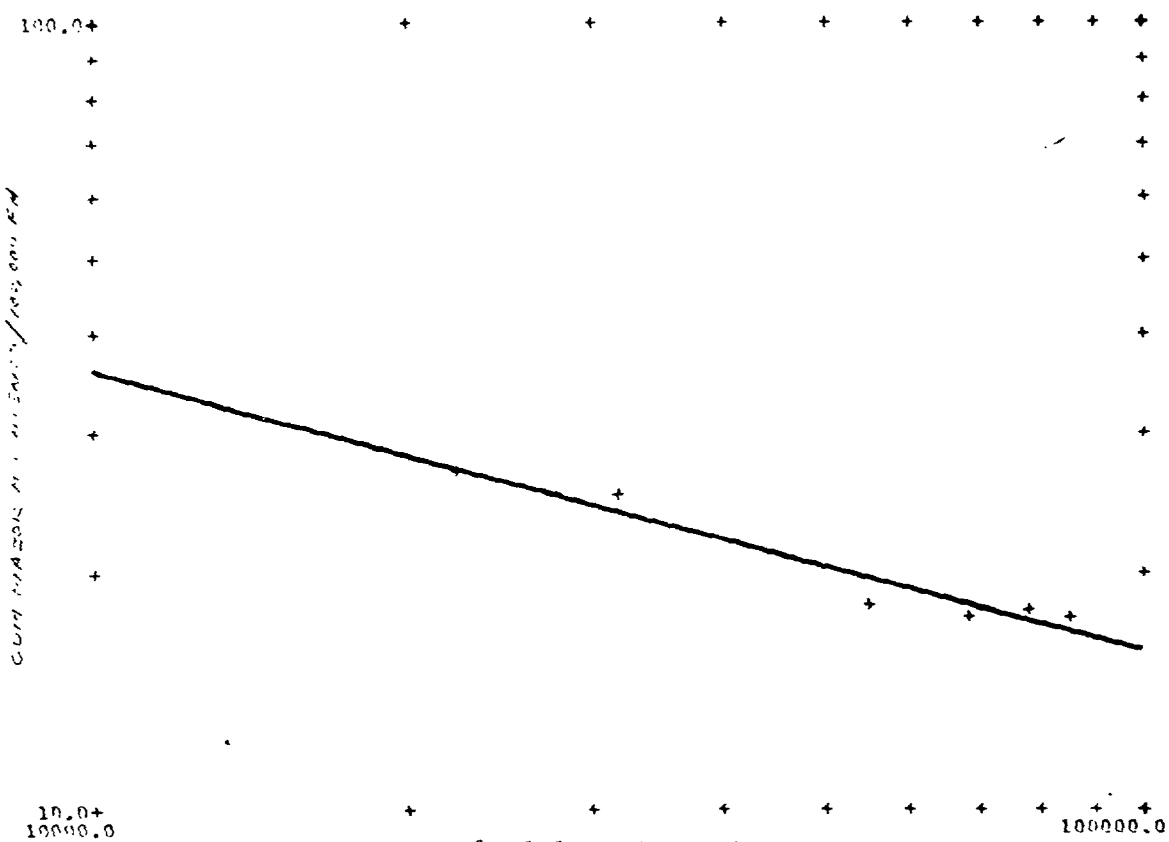


6.175143 -.269903 11.730753 3.026??? .521425 .163571 -.947598 - Parameters for Two Pts

BETA ALPHA R OMITTED REGRESSION

CH-53 .SMC

FIGURE 41



6.846414 -.354156 10.8?9163 1.0? 5?? .490?46 .179871 -.966249

BETA ALPHA K

CH-54 ARMY

FIGURE 42

SAFETY GROWTH PARAMETERS

AIRCRAFT	MAJOR ACCIDENT RATE /100,000 FLT. HRS.		
	B	α	R
UH-1 ARMY	5.775	-.161	-.940
UH-1 NAVY/USMC	2.202	.054	.394
H-2 NAVY	7.796	-.339	-.978
H-3 NAVY	6.661	-.327	-.990
OH-6 ARMY	5.185	-.096	-.948
H-19 NAVY	5.350	-.102	-.636
H-19 ARMY	13.772	-.742	-.991
H-21 A/B USAF	6.706	-.243	-.982
H-21C ARMY	1.848	.158	.906
H-34 ARMY	8.031	-.335	-.973
H-34 NAVY/USMC	6.528	-.254	-.983
H-37 NAVY	9.362	-.479	-.997
H-37 ARMY	5.266	-.156	-.776
UH/CH-46 ALL MODELS	2.985	-.015	-.073
CH-47 ALL MODELS	6.079	-.266	-.976
CH-53 USMC	6.175	-.270	-.948
CH-54 ARMY	6.846	-.354	-.966

TABLE 4

THE BOEING COMPANY

PREPARED BY
CHECKED BY
DATE

MODEL NO

NUMBER
REV LTR

MALFUNCTIONS PER FLIGHT HOUR

SYSTEM

CUM FLIGHT HOURS	YEAR	AIRFRAME Λ	AIRFRAME CUM Λ	ROTOR Λ	ROTOR CUM Λ	INSTRUMENT Λ	INSTRUMENT CUM Λ	LANDING GEAR Λ	LANDING GEAR CUM Λ	INTEGRATED ELEC. CONTROL Λ	INTEGRATED ELEC. CONTROL CUM Λ
10,000	1962										
2,000	1963										
25,000	1964										
60,000	1965										
130,000	1966										
228,041	1967										
394,129	1968	.54	.64	.076	.076	.073	[illegible]	.048	[illegible]	.046	[illegible]
563,346	1969	.056	.126	.080	.11	.058	[illegible]	.040	.46	.054	[illegible]
717,689	1970	.093	.118	.075	[illegible]	.062	.067	.048	[illegible]	.050	[illegible]
825,000	1971										
964,000	1972	.119	[illegible]	.121	[illegible]	.075	[illegible]	[illegible]	[illegible]	.057	[illegible]

CUM FLIGHT HOURS	YEAR	FLIGHT CONTROLS Λ	FLIGHT CONTROLS CUM Λ	HYDRAULIC POWER SUPPLY Λ	HYDRAULIC POWER SUPPLY CUM Λ	DRIVE Λ	DRIVE CUM Λ	LIGHTING Λ	LIGHTING CUM Λ	RADIO NAVIGATION Λ	RADIO NAVIGATION CUM Λ	ELECT. PWR. SUPPLY Λ	ELECT. PWR. SUPPLY CUM Λ
10,000	1962												
2,000	1963												
25,000	1964												
60,000	1965												
130,000	1966												
228,041	1967												
394,129	1968	.041	.041	.036	[illegible]	.029	[illegible]	.026	.026	.024	.024	.022	.022
563,346	1969	.041	.041	.027	[illegible]	.034	[illegible]	.022	.025	.045	.030	.021	.022
717,689	1970	.031	[illegible]	.032	[illegible]	.039	[illegible]	.014	.022	.038	[illegible]	.028	.023
825,000	1971												
964,000	1972	.068	[illegible]	.042	[illegible]	.061	.040	.028	.024	.044	[illegible]	.045	.029

SYSTEM

CUM FLIGHT HOURS	YEAR	[illegible] UNIT Λ	[illegible] UNIT CUM Λ	TURBOSHAFT ENGINES Λ	TURBOSHAFT ENGINES CUM Λ	INTERPHONE Λ	INTERPHONE CUM Λ	UHF COMMUNICATION Λ	UHF COMMUNICATION CUM Λ	HF COMMUNICATION Λ	HF COMMUNICATION CUM Λ
10,000	1962										
12,000	1963										
25,000	1964										
60,000	1965										
130,000	1966										
228,041	1967										
394,129	1968	.011	.011	.020	.020	.018	.018	.015	[illegible]	.012	.012
563,806	1969	.053	.016	.014	.018	.017	.018	.020	.017	.011	.018
717,639	1970	.089	.016	.018	.018	.010	.016	.019	.017	.008	.016
825,000	1971										
964,000	1972	.087	.018	.028	.021	.013	[illegible]	.020	.017	.015	.015

CUM FLIGHT HOURS	YEAR	FUSELAGE COMPART. Λ	FUSELAGE COMPART. CUM Λ	ACE FLEXPLANT Λ	ACE FLEXPLANT CUM Λ	IFF Λ	IFF CUM Λ	RADAR NAVIGATION Λ	RADAR NAVIGATION CUM Λ	AIR COND. & ICE CONTROL Λ	AIR COND. & ICE CONTROL CUM Λ	FUEL Λ	FUEL CUM Λ
10,000	1962												
12,000	1963												
25,000	1964												
60,000	1965												
130,000	1966												
228,041	1967												
394,129	1968	.011	.011	.011	.011	.009	.009	.009	.009	.006	.006	.005	.005
563,806	1969	[illegible]	.013	.011	.011	.009	.009	.010	.009	.002	.005	.005	.005
717,639	1970	.013	.013	.013	.011	.004	.006	.008	.008	.006	.005	.004	.006
825,000	1971												
964,000	1972	.028	.017	.013	.012	.006	.007	.007	.008	.009	.006	.005	.005

SYSTEM

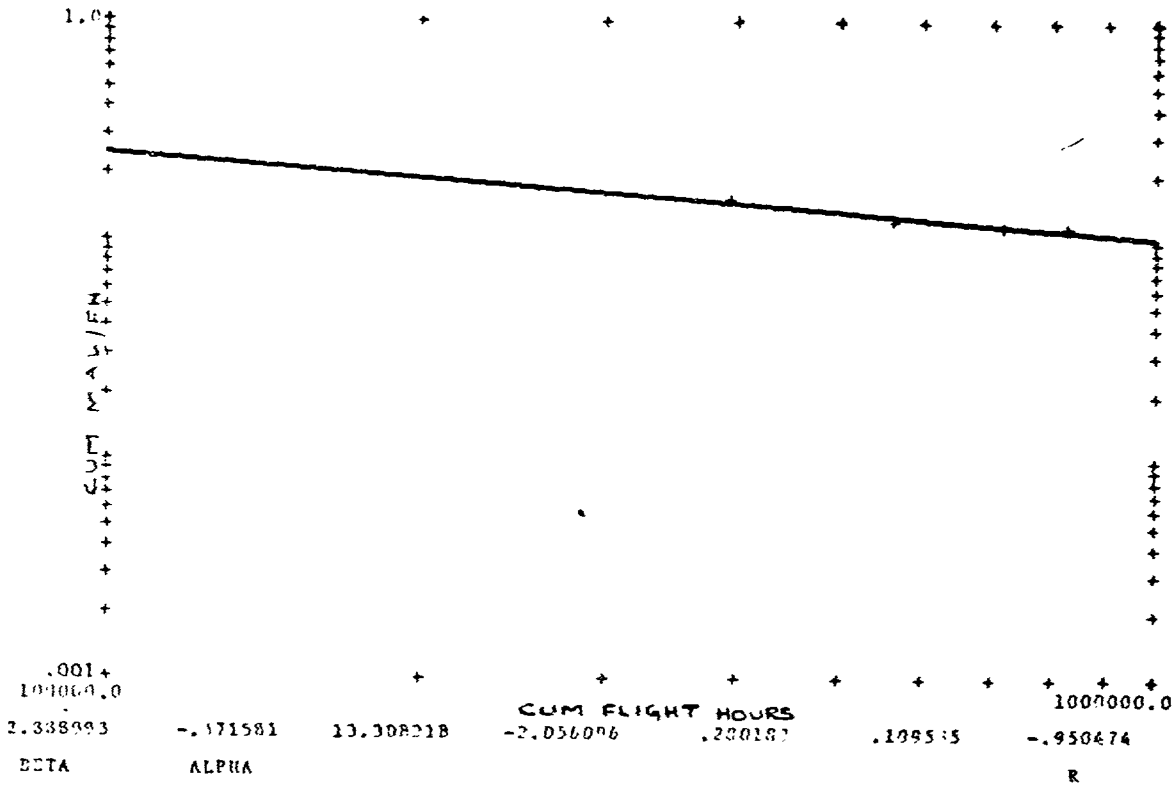
CUM FLIGHT HOURS	YEAR	MISC. UTILITIES Λ	MISC. UTILITIES CUM Λ	TOTAL Λ	TOTAL CUM Λ
19,000	1962			2.0	2.00
12,000	1963			1.5	1.92
26,000	1964			1.1	1.49
60,000	1965			1.0	1.21
130,000	1966			8	.99
228,041	1967			8	.91
394,129	1968	.002	.002	.723	.83
563,806	1969	.005	.003	.661	.77
717,639	1970	.003	.003	.639	.75
825,000	1971				
964,000	1972	.006	.003	.925	.79

INCLUDE VIETNAM OPERATIONS

*** - DATA SOURCE BOEING-VERTOL DATA BANK ***

SHEET

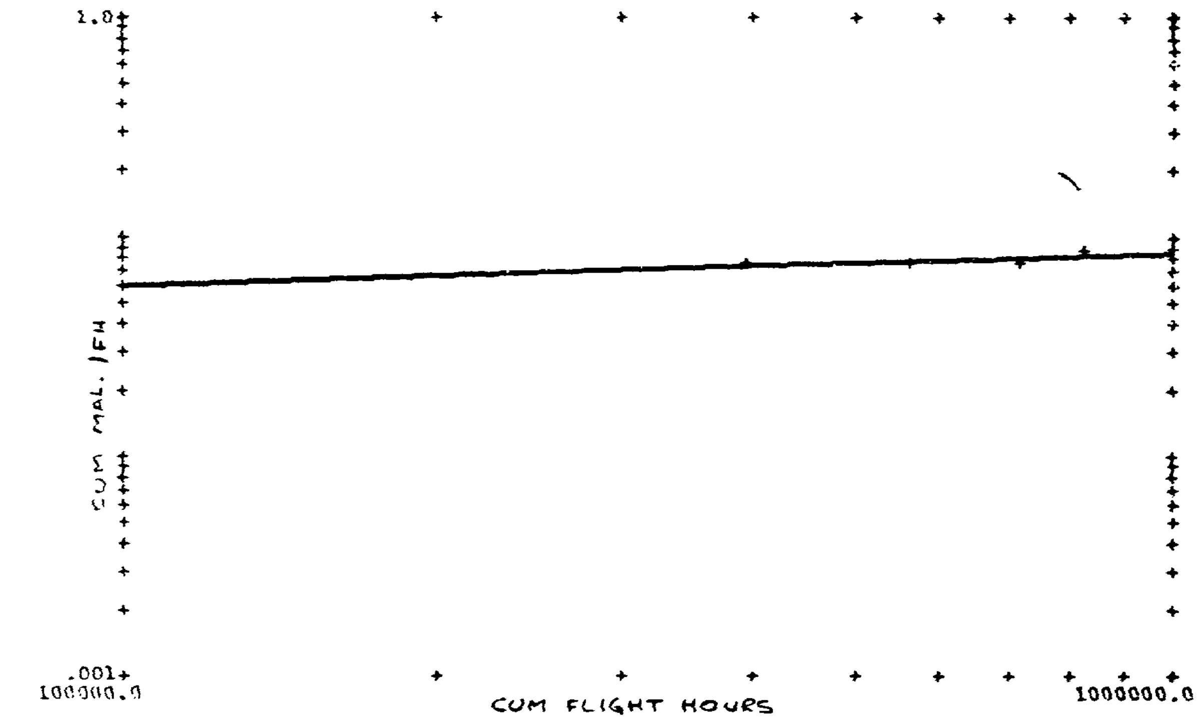
Best Available Copy



AIRFRAME

CH-46 MAL./FH - CUM

FIGURE 43



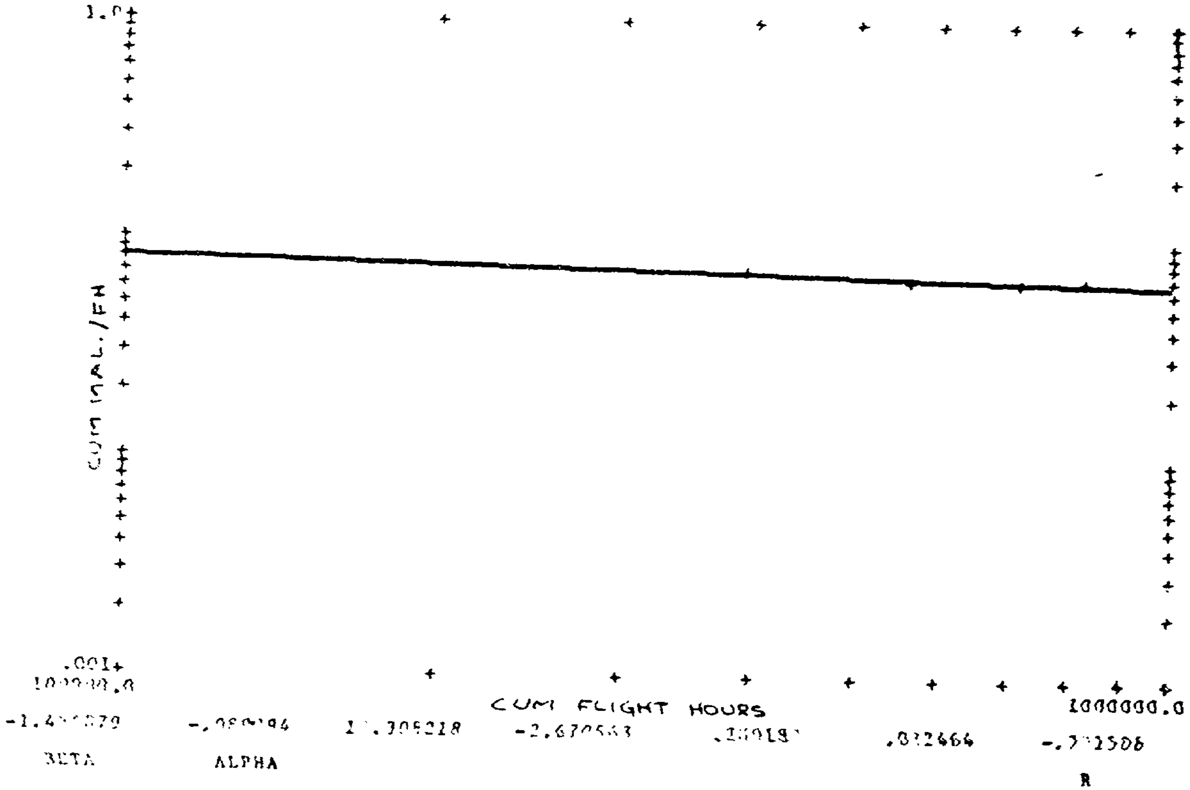
-4.550830 .151560 1?.308218 -2.53?8 5 .230183 .059945 .708326

BETA ALPHA R

ROTOR

CH-46 MAL./FH - CUM

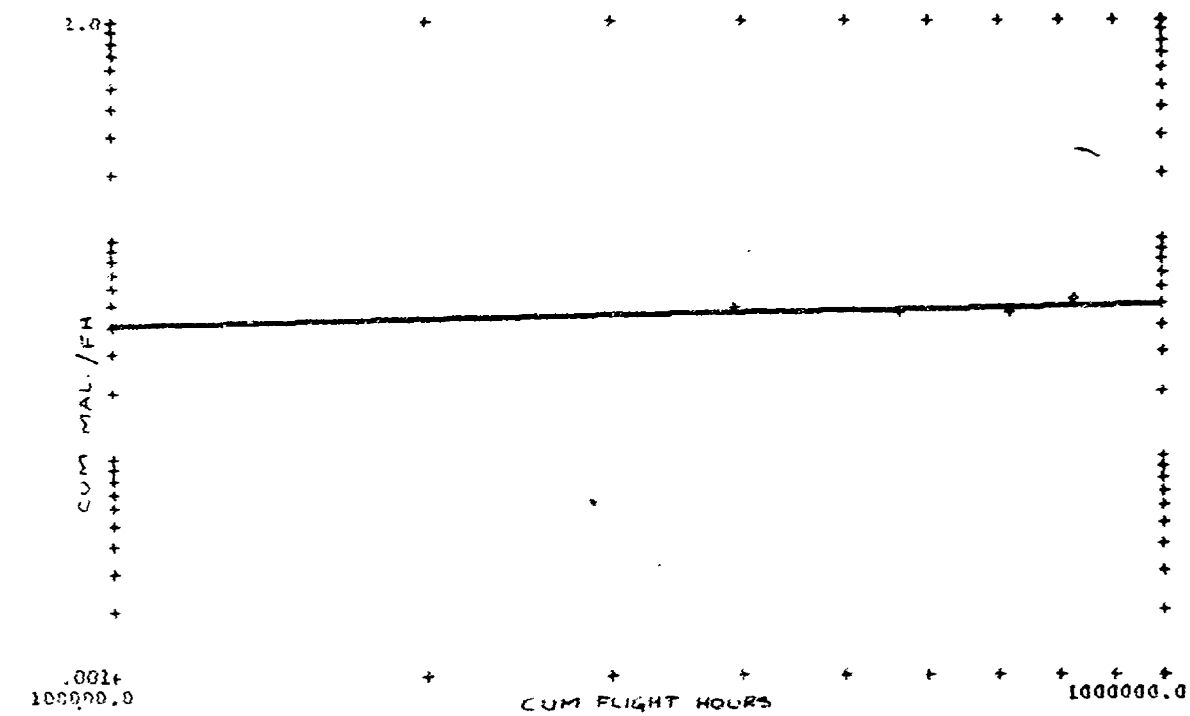
FIGURE 44



INSTRUMENT

CH-46 MAL./FH - CUM

FIGURE 45



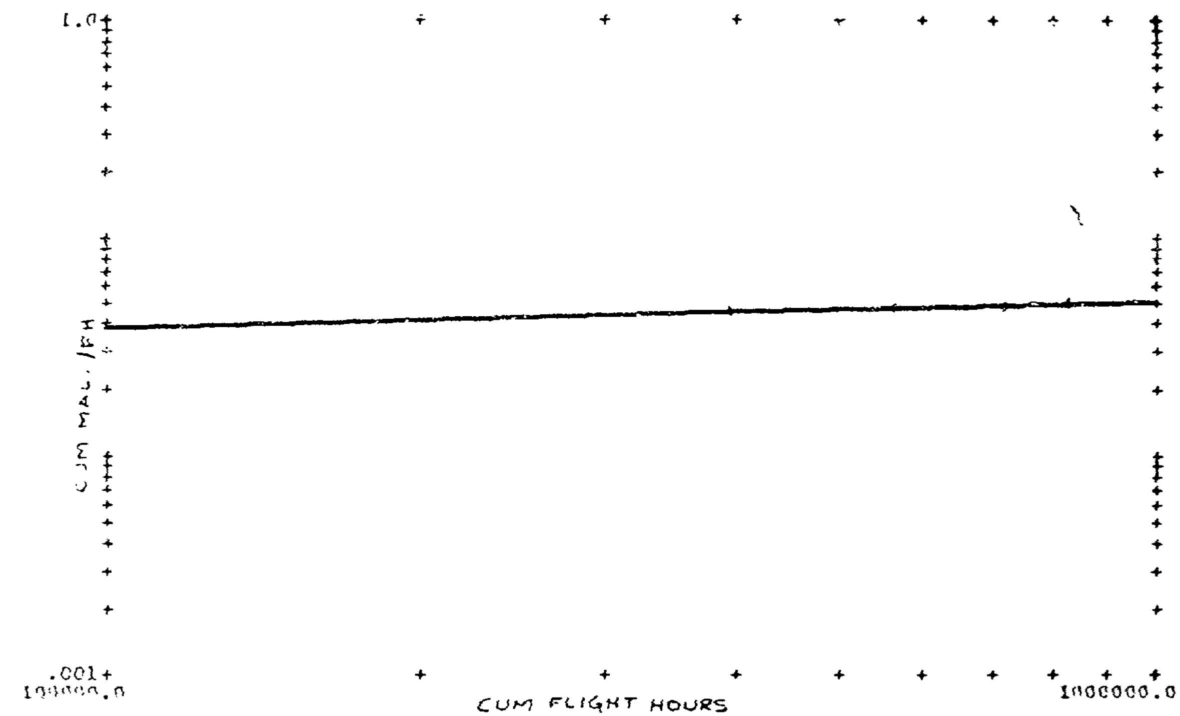
-4.159243 .084623 13.308218 -3.033061 .200183 .057863 .409755

BETA ALPHA R

LANDING GEAR

CH-46 MAL./FH - CUM

FIGURE 46



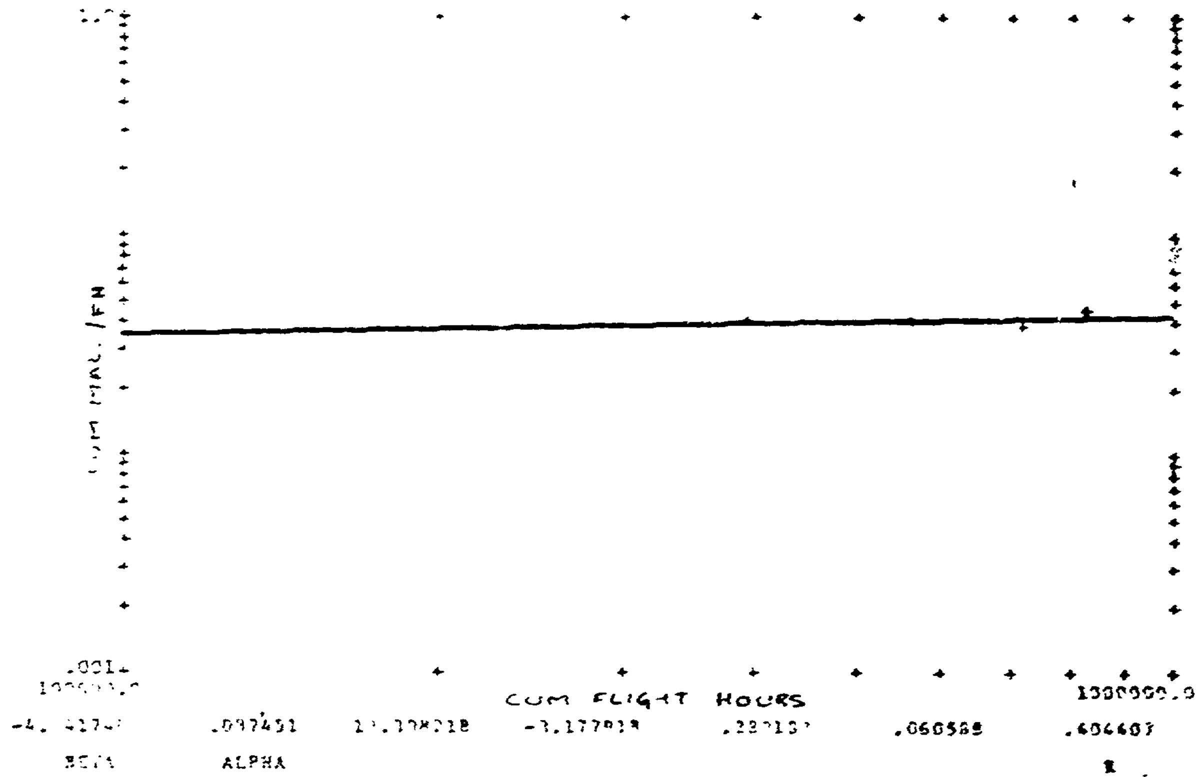
-4.751799 .129762 11.309318 -3.026887 .280187 .017207 .977139

BETA ALPHA R

INTEGRATED GUIDANCE & FLIGHT CONTROL

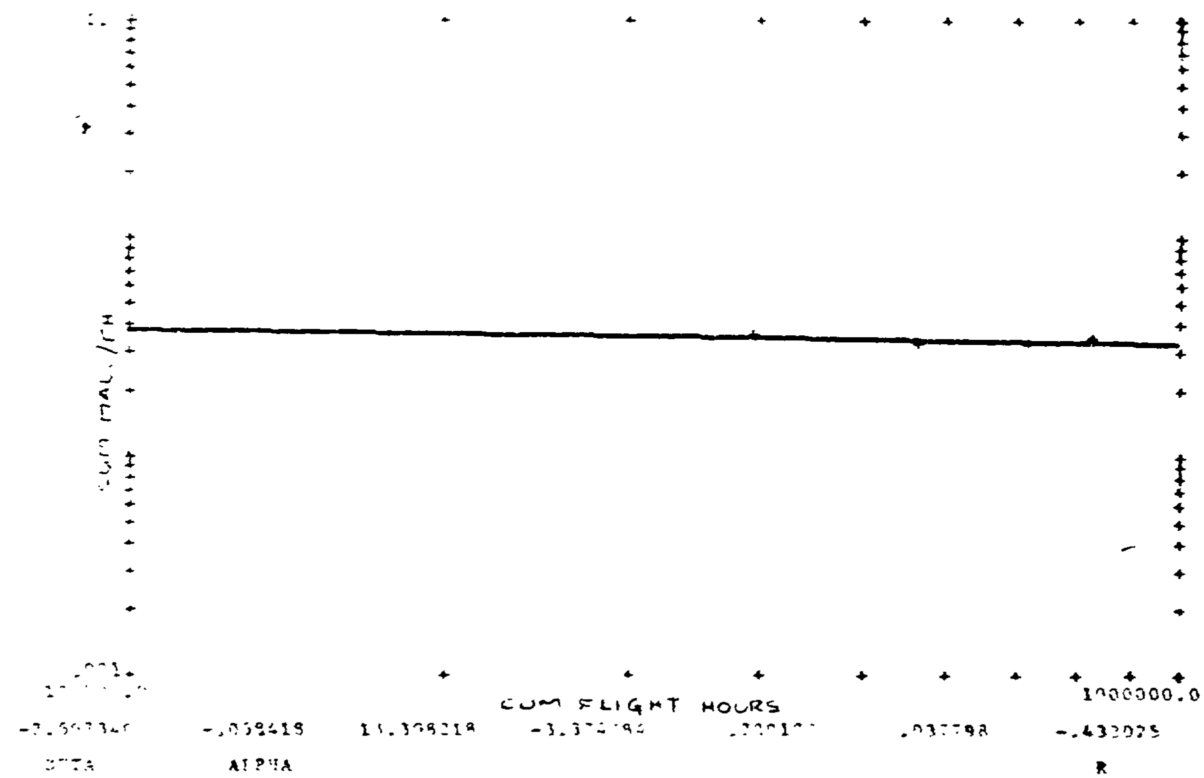
CH-46 MAL./FH - CUM

FIGURE 47



FLIGHT CONTROLS
CH-46 MAL./FH - CUM

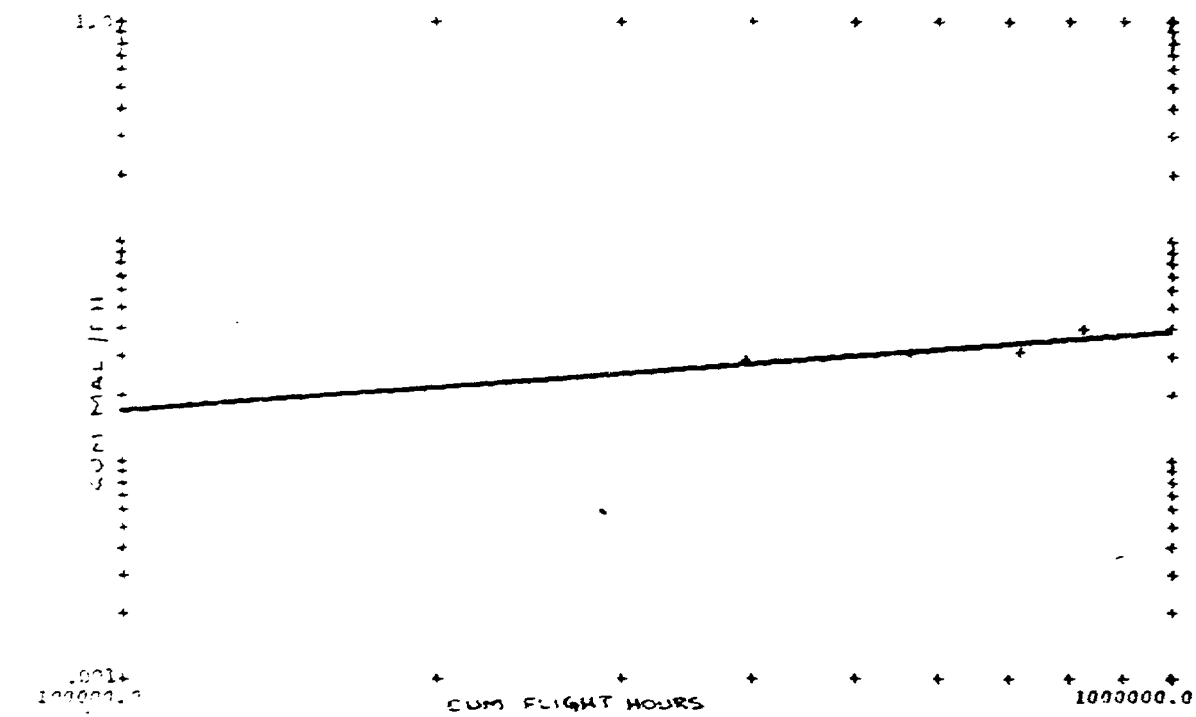
FIGURE 48



HYDRAULIC POWER SUPPLY

CH-46 MAL./FH - CUM

FIGURE 49



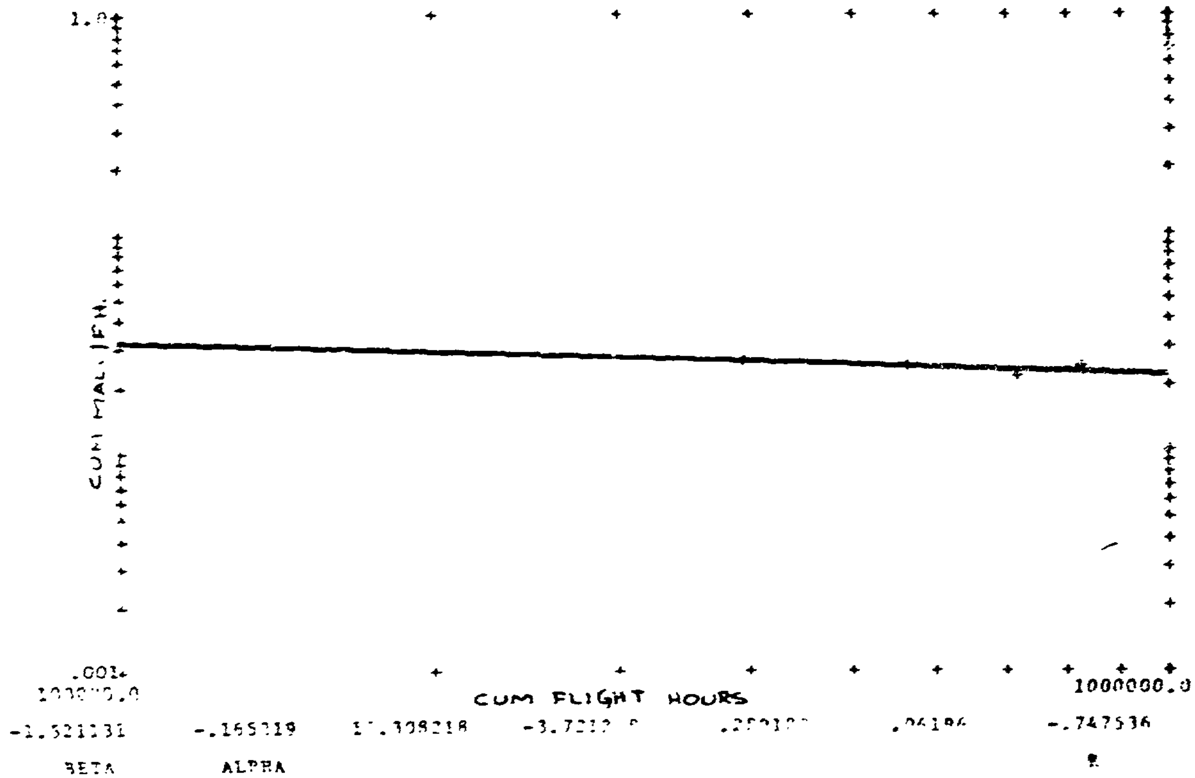
-8.294736 .363381 1 .30821 -3.419780 .28018 .120759 .43109

BETA ALPHA R

DRIVE

CH-46 MAL./FH - CUM

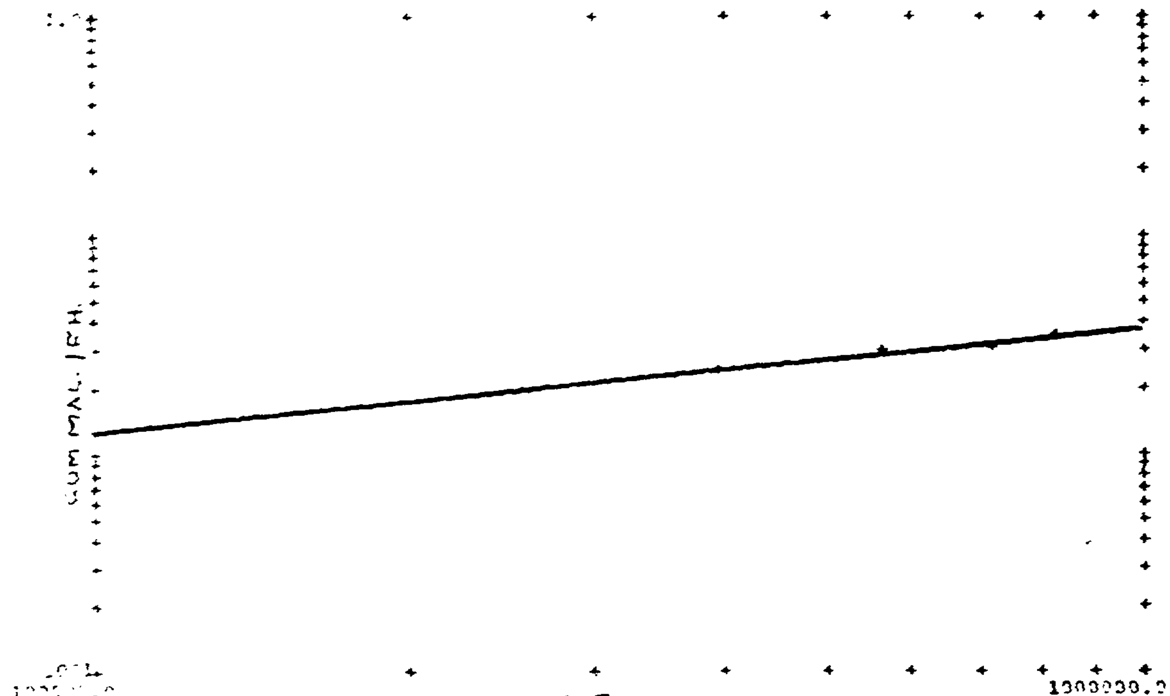
FIGURE 50



LIGHTING

CH-46 MAL./FH - CUM

FIGURE 51

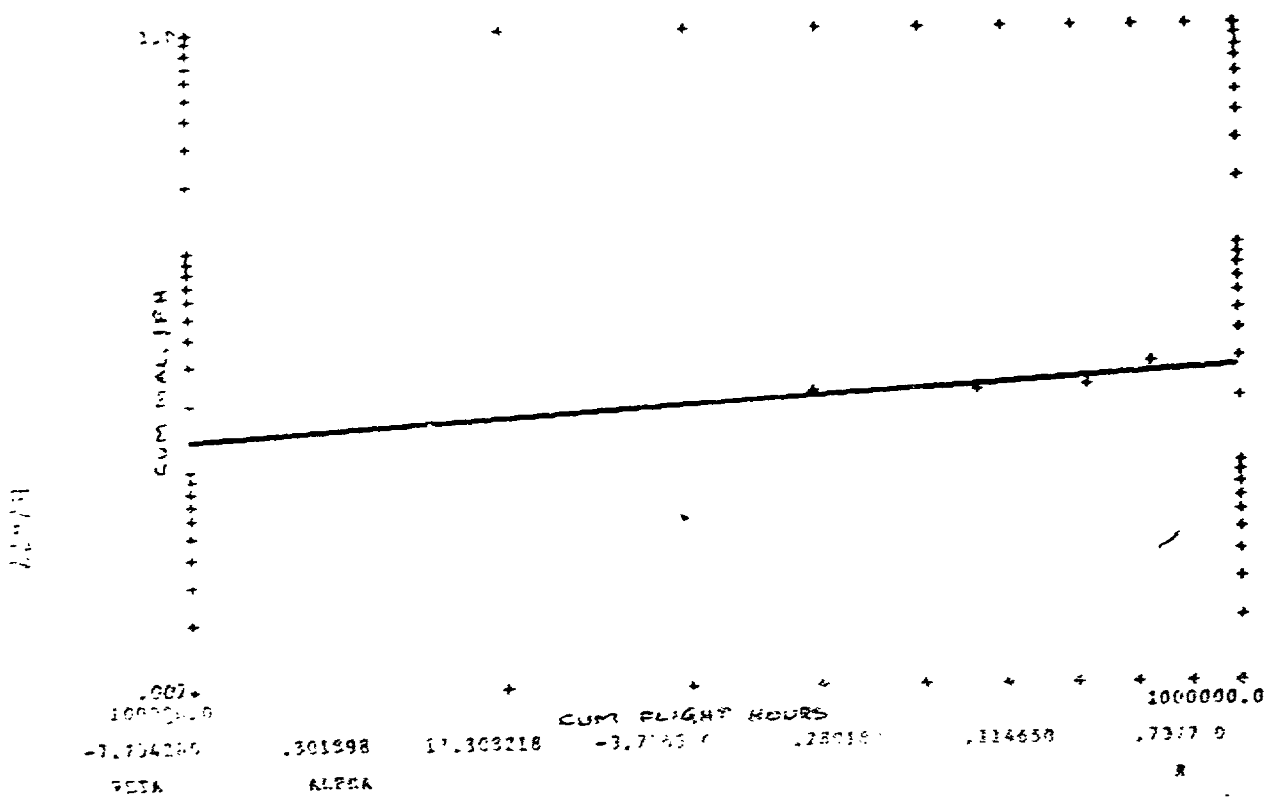


BETA	ALPHA					R
[illegible]	.4?8073	[illegible]	-3.515[illegible]	.2[illegible]	.1[illegible]6292	.974577

RADIO NAVIGATION

CH-46 MAL./FH - CUM

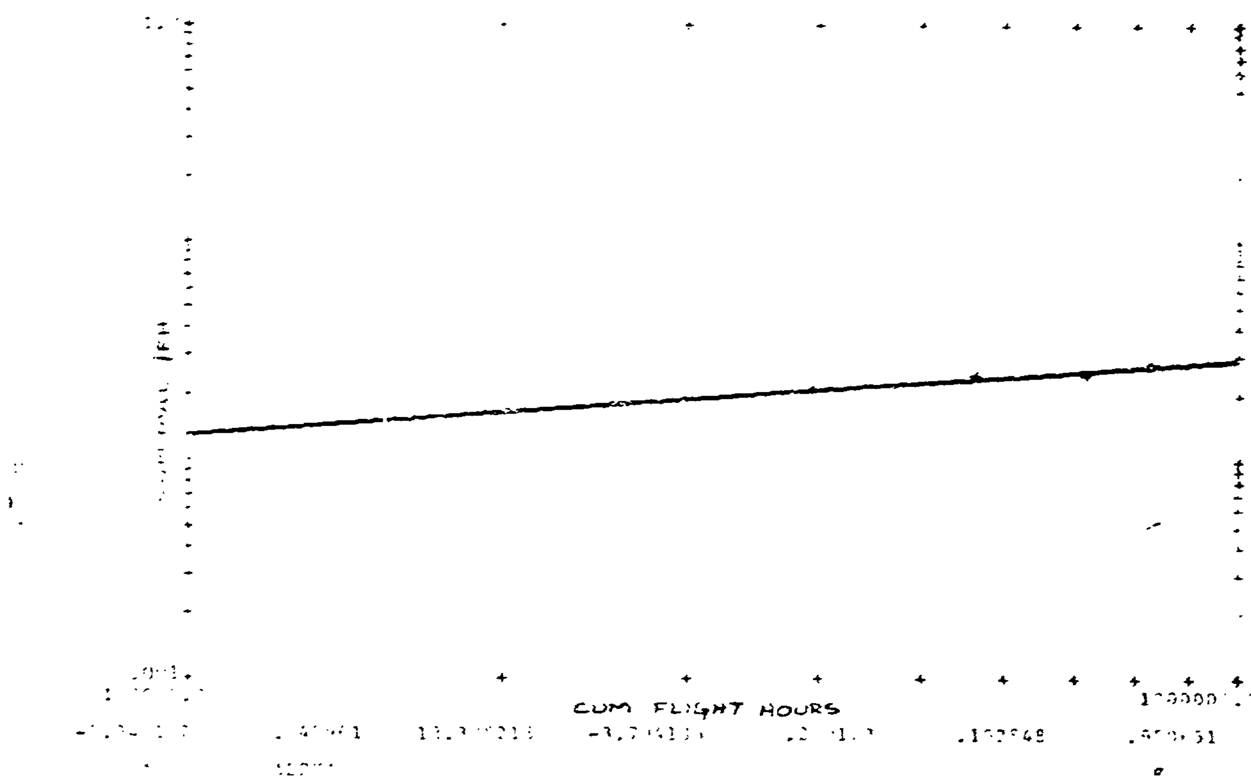
FIGURE 52



ELECTRICAL POWER SUPPLY

CH-46 MAL./TH - CUM

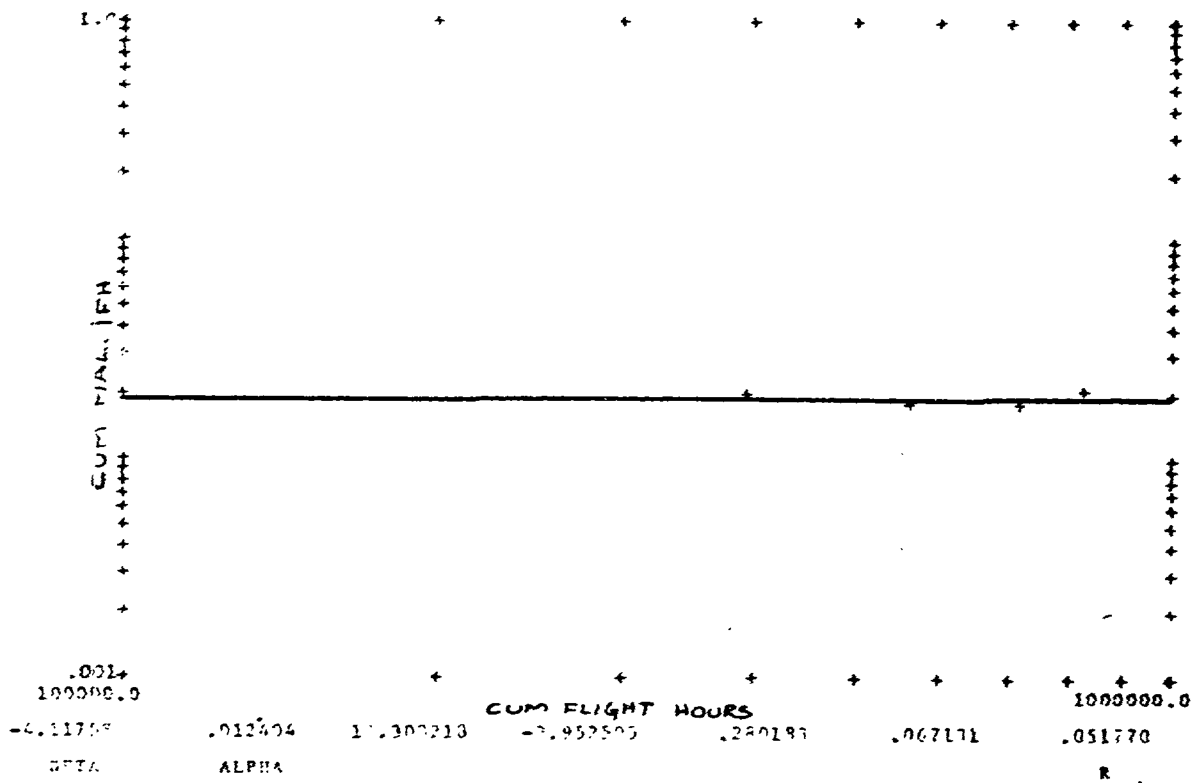
FIGURE 53



POWERPLANT INSTALLATION

CH-46 MAL./FH - CUM

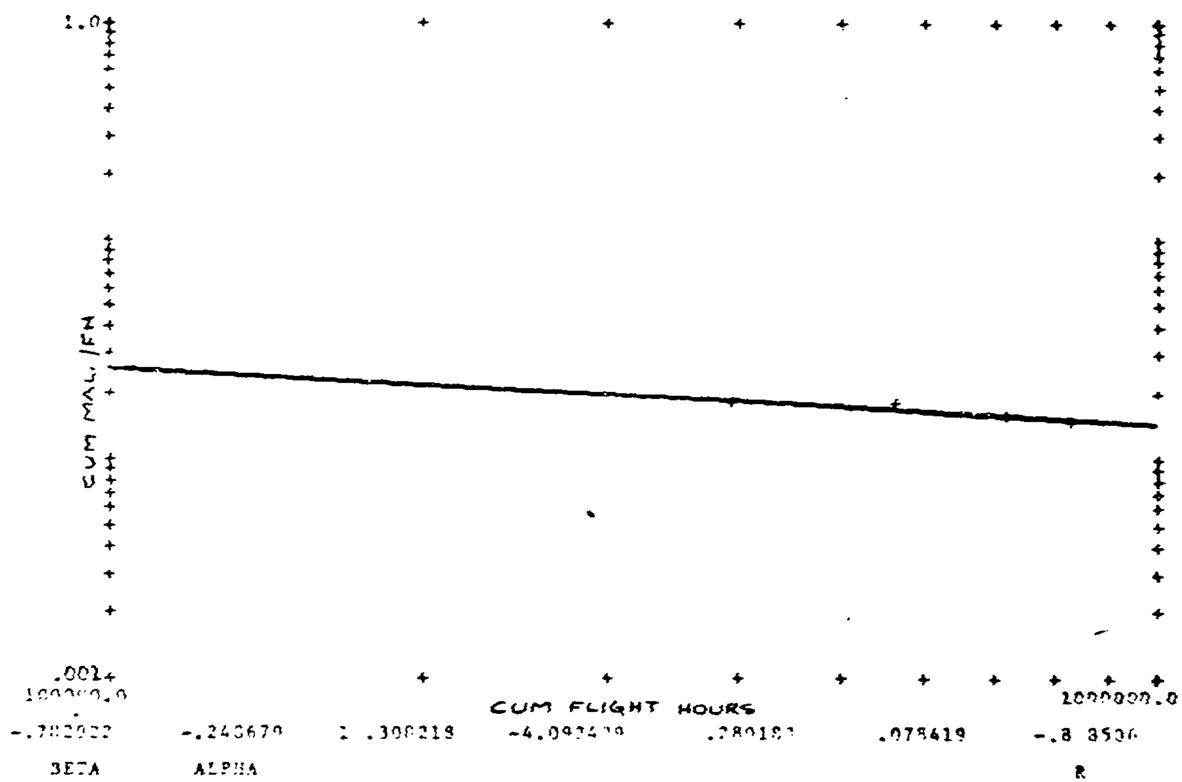
FIGURE 54



TURBOSHAFT ENGINES

CH-46 MAL./FH - CUM

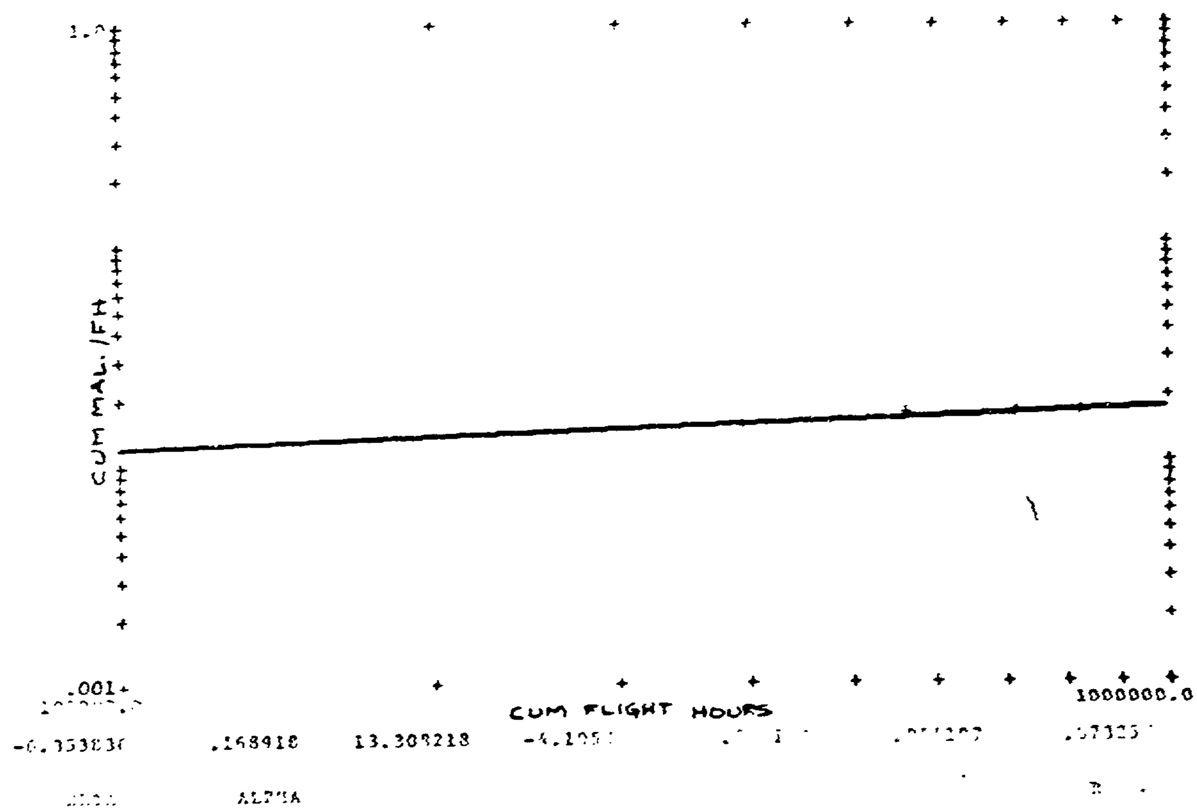
FIGURE 55



INTERPHONE

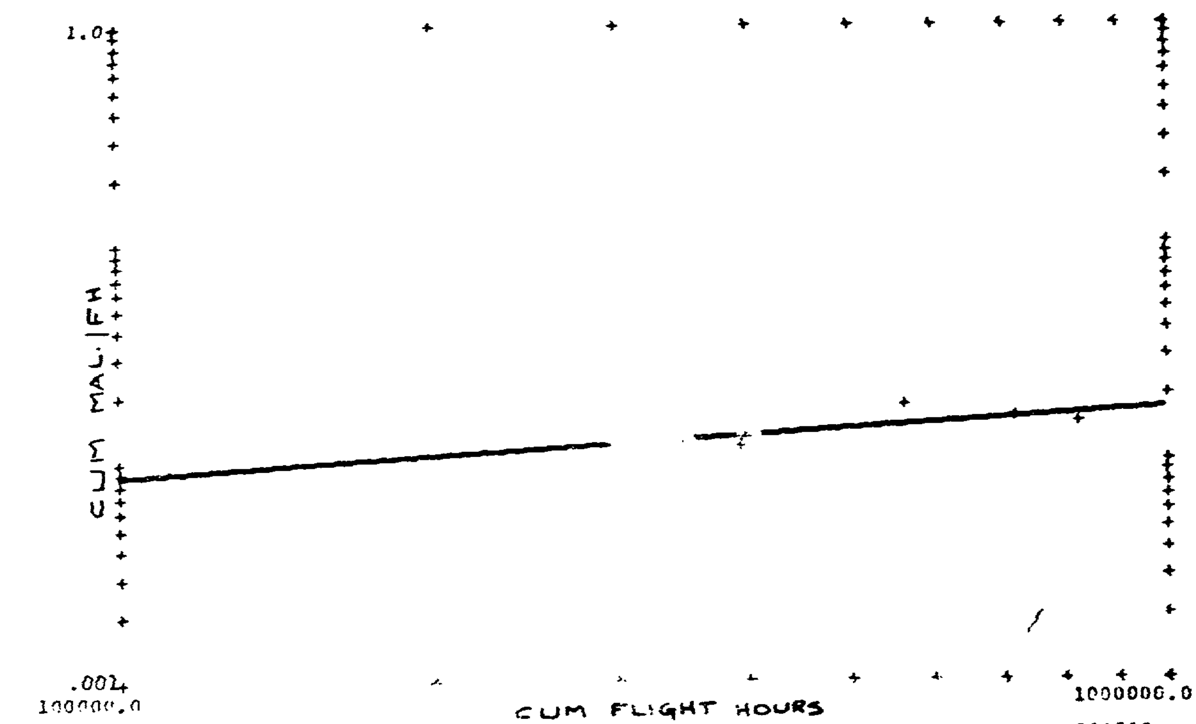
CH-46 MAL./FH - CUM

FIGURE 56



CH-46 MAL./FH - CUM

FIGURE 57

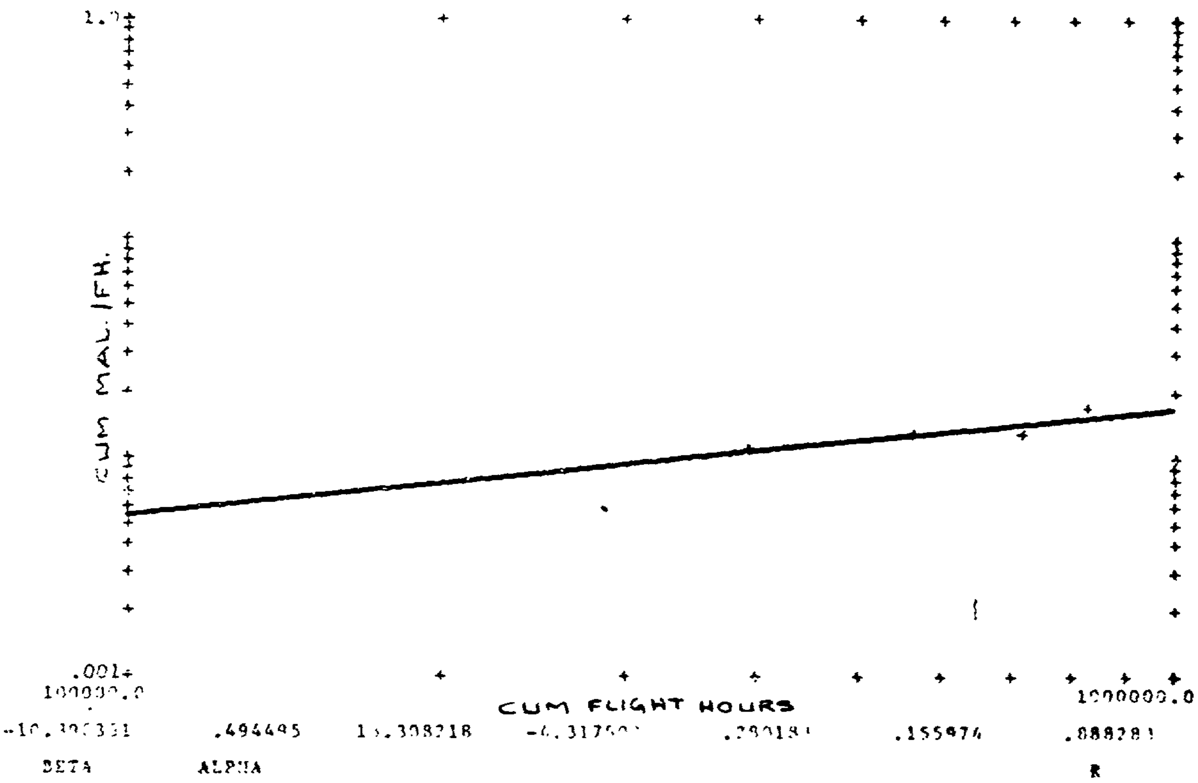


-8.146679	.299530	17.308218	-4.19775	.20018	.147528	.566962
BETA	ALPHA					R

HF COMMUNICATIONS

CH-46 MAL./FH - CUM

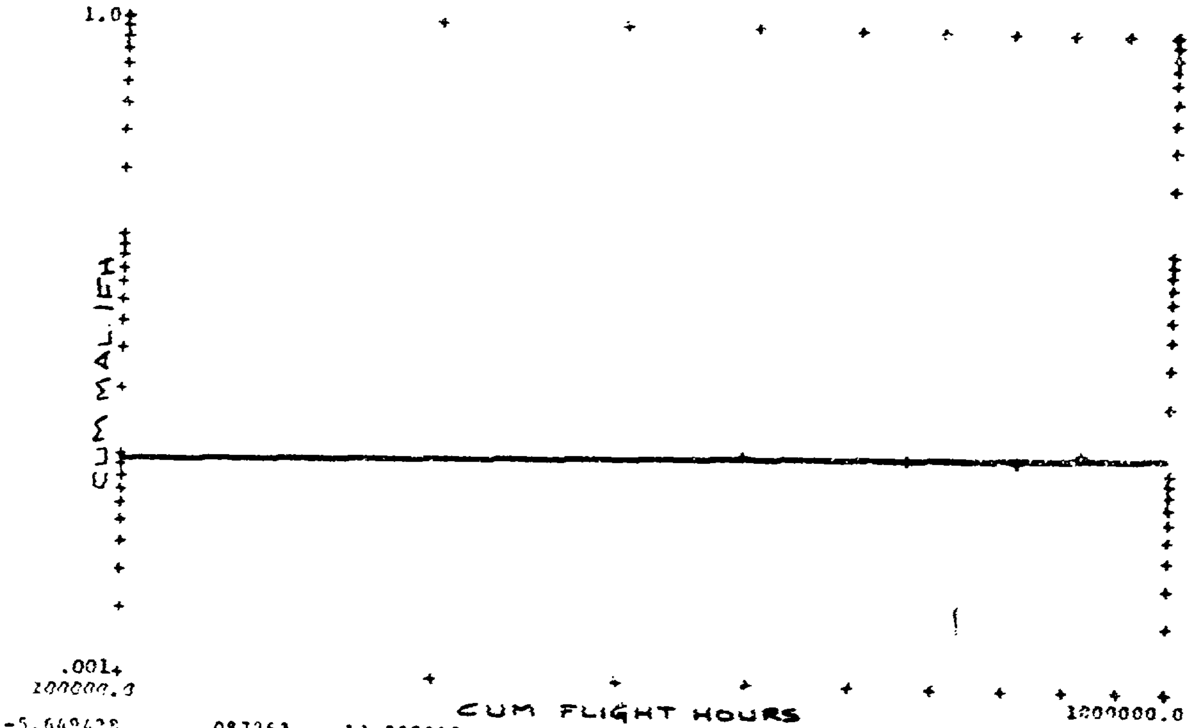
FIGURE 58



FUSELAGE COMPARTMENT

CH-46 MAL./FH - CUM

FIGURE 59



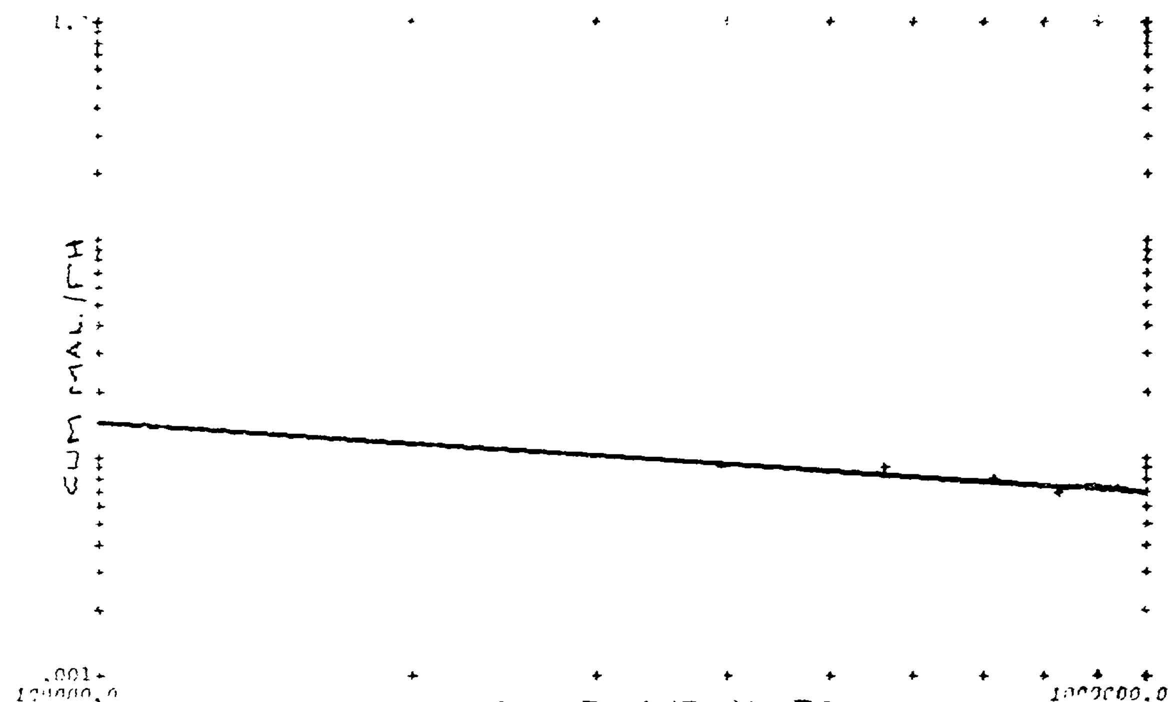
-5.649428 .087263 11.308210 -4.48 197 .2?019? .017677 .648930

BETA ALPHA R

AUX. POWERPLANT

CH-46 MAL./FH - CUM

FIGURE 60



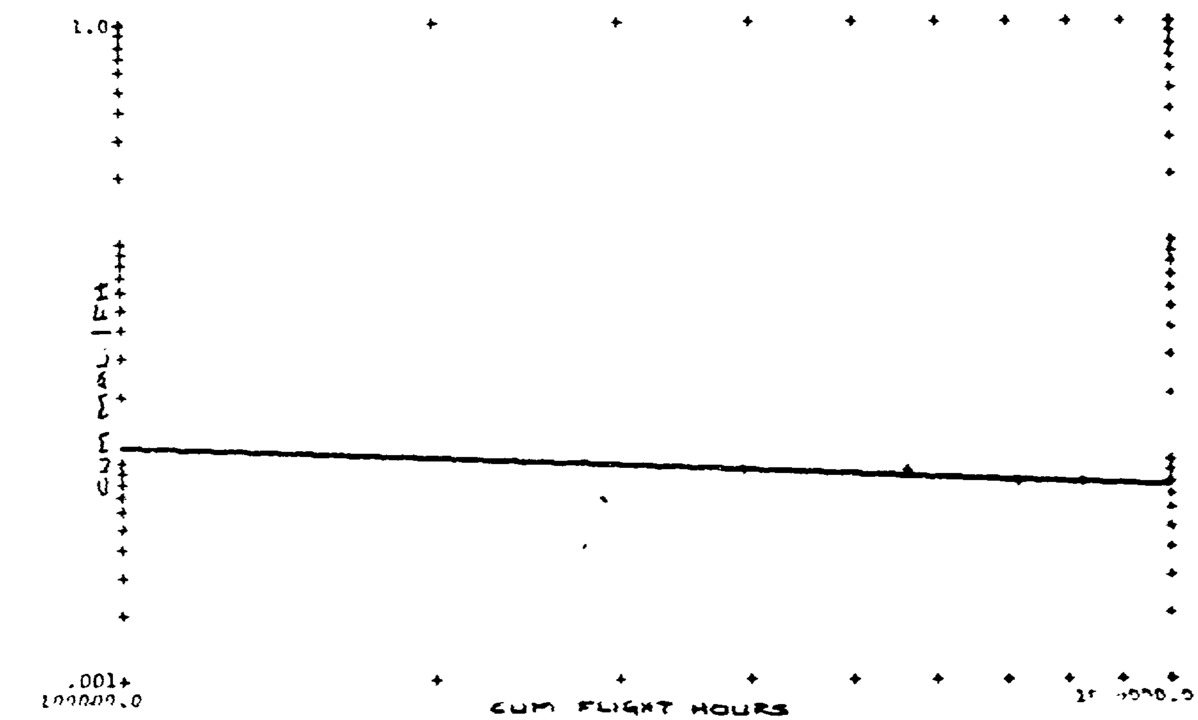
-.572485 -.317872 13.308219

BETA ALPHA

IFF

CH-46 MAL./FH - CUM

FIGURE 61

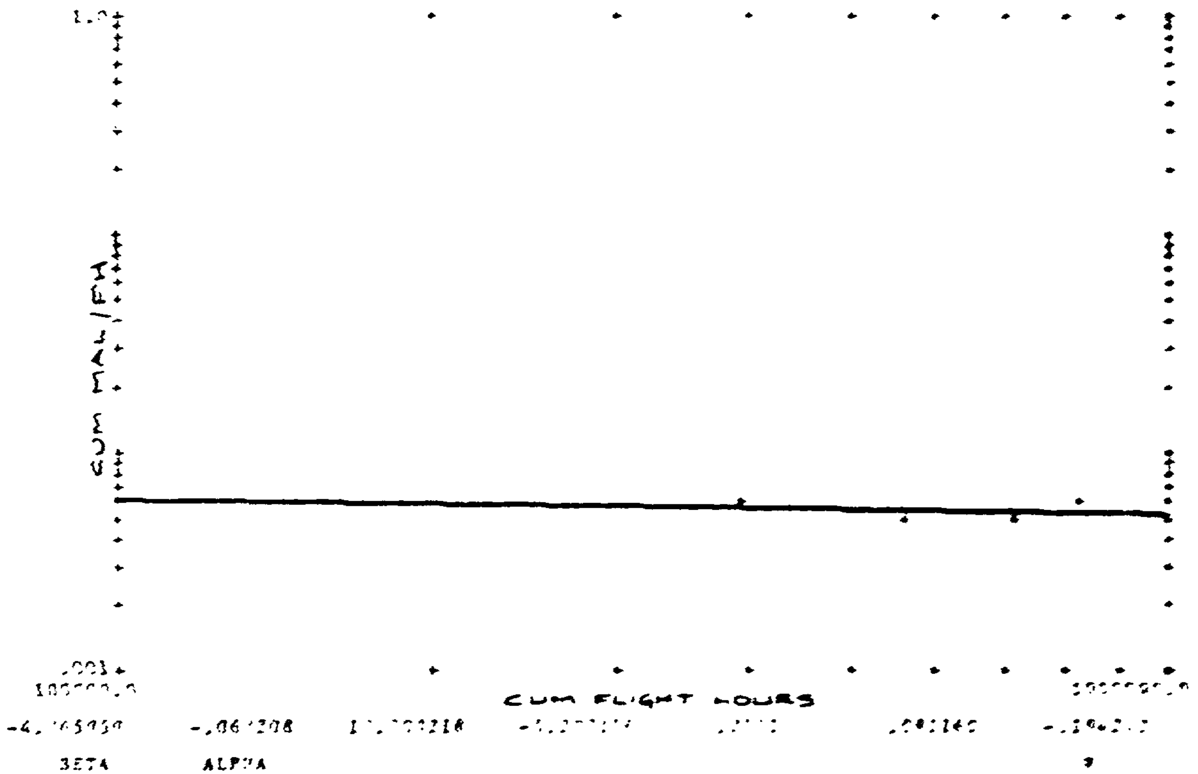


-2.321 16	-.183954	1?.308218	-4.769422	.26919	.053991	.5?5184
BETA	ALPHA					R

RADAR NAVIGATION

CH-46 MAL./FH - CUM

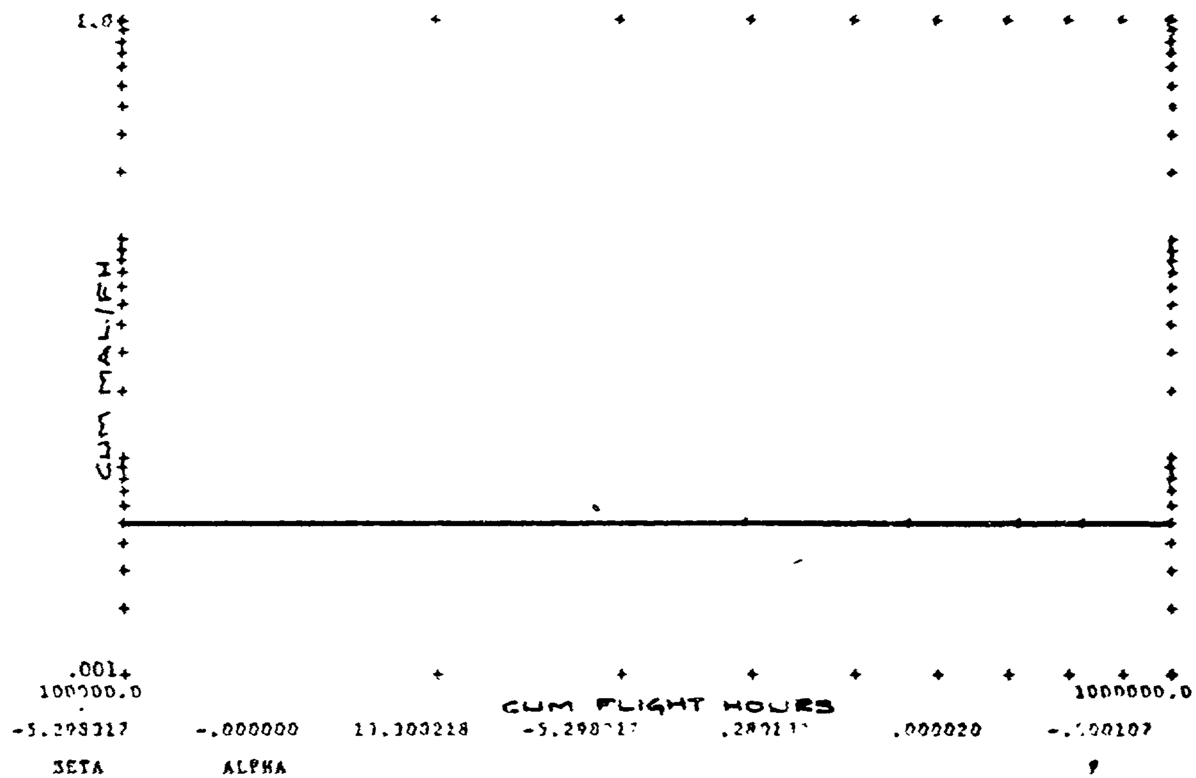
FIGURE 62



AIR CONDITIONING - ICE CONTROL

CH-46 MAL./FH - CUM

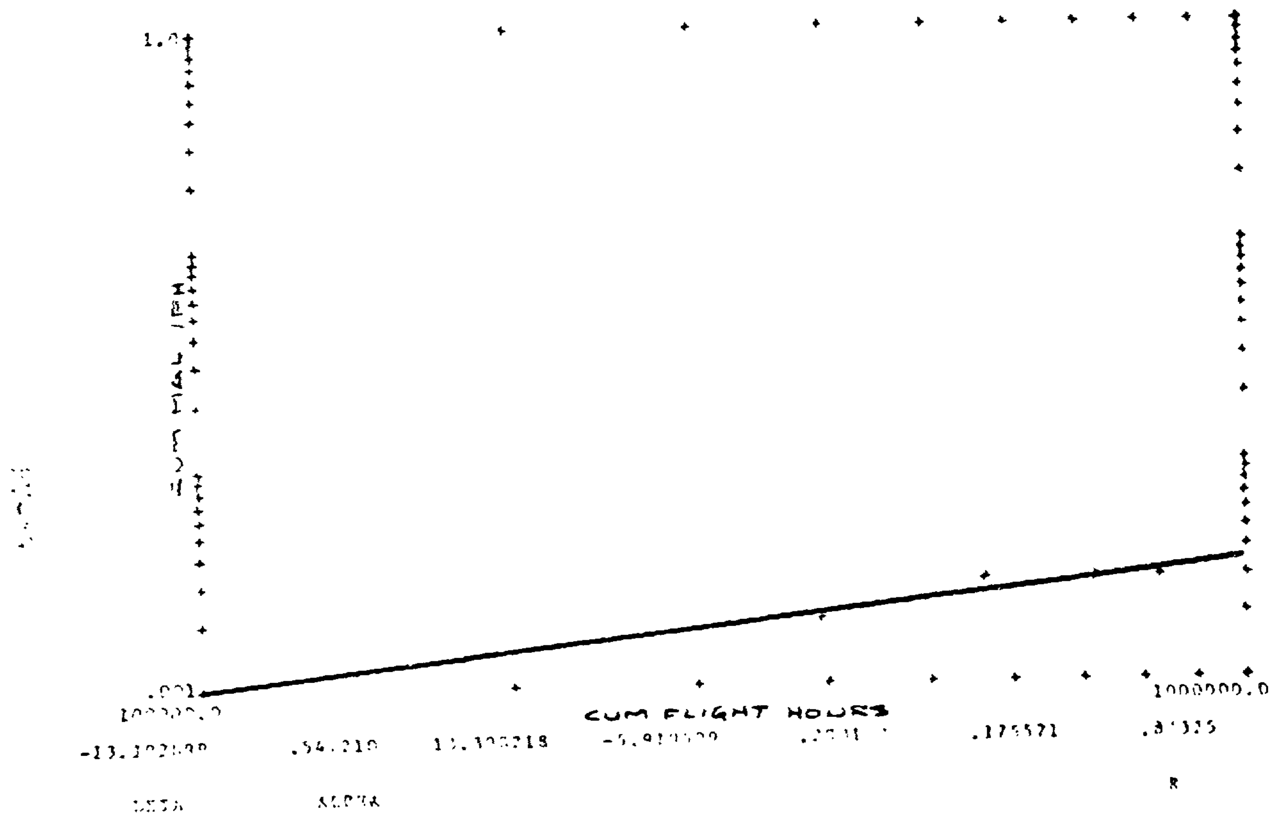
FIGURE 63



FUEL

CH-46 MAL./FH - CUM

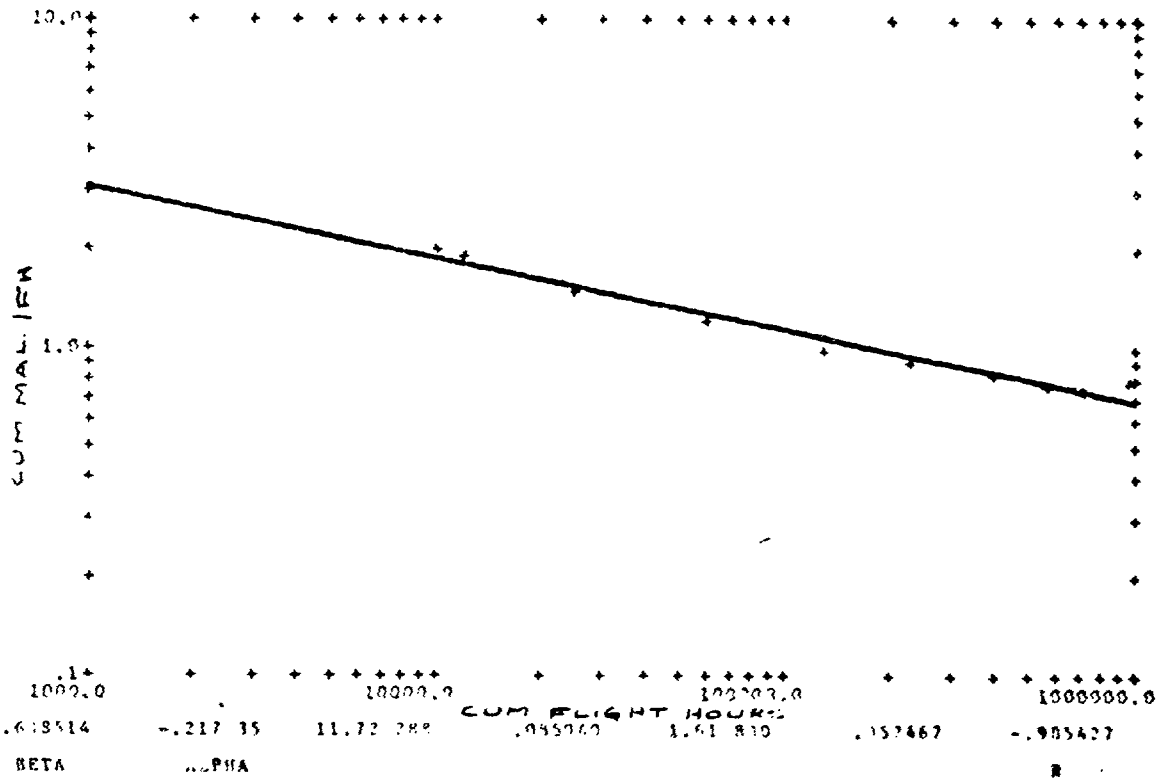
FIGURE 64



ISC- UTILITIES

CH-46 MAL./FH - CUM

FIGURE 65



TOTAL

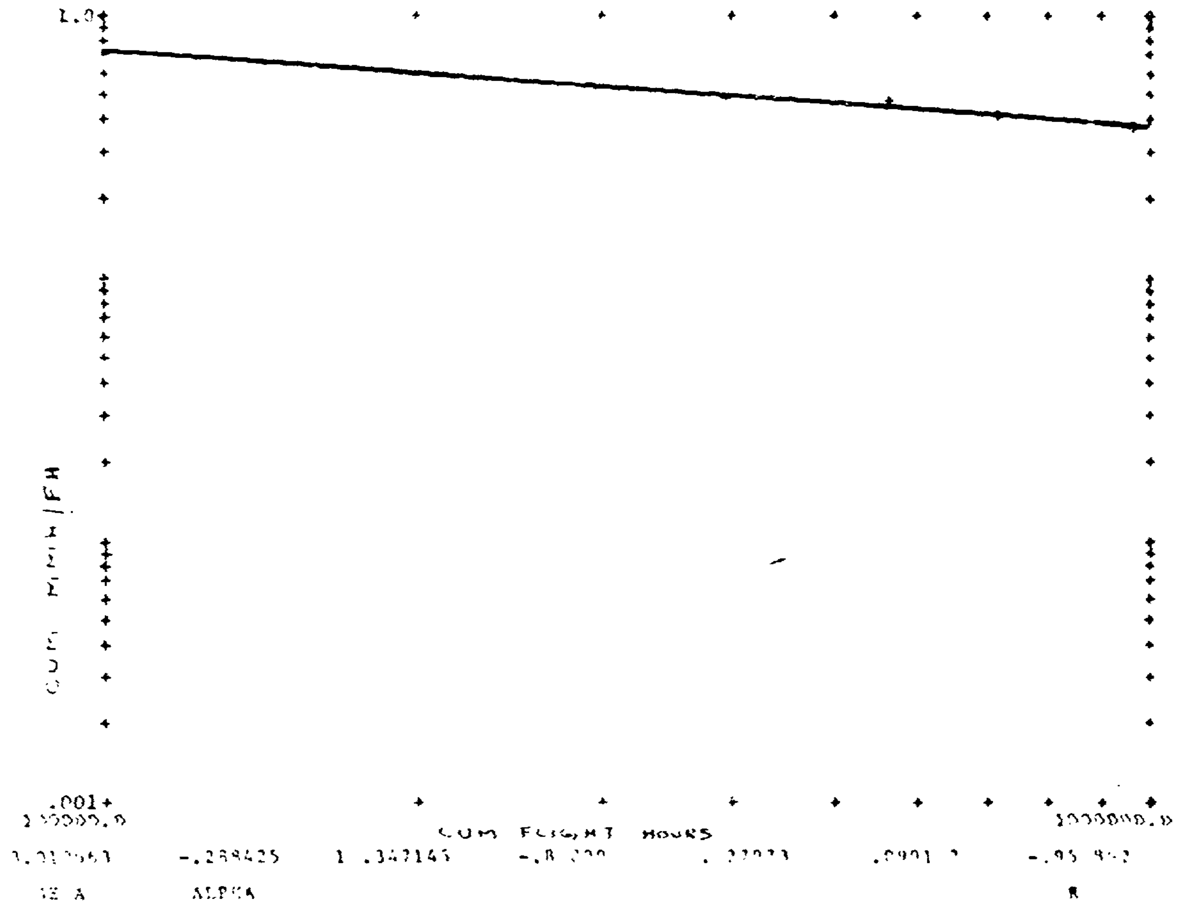
CH-46 MAL./FH - CUM

FIGURE 66

BOEING

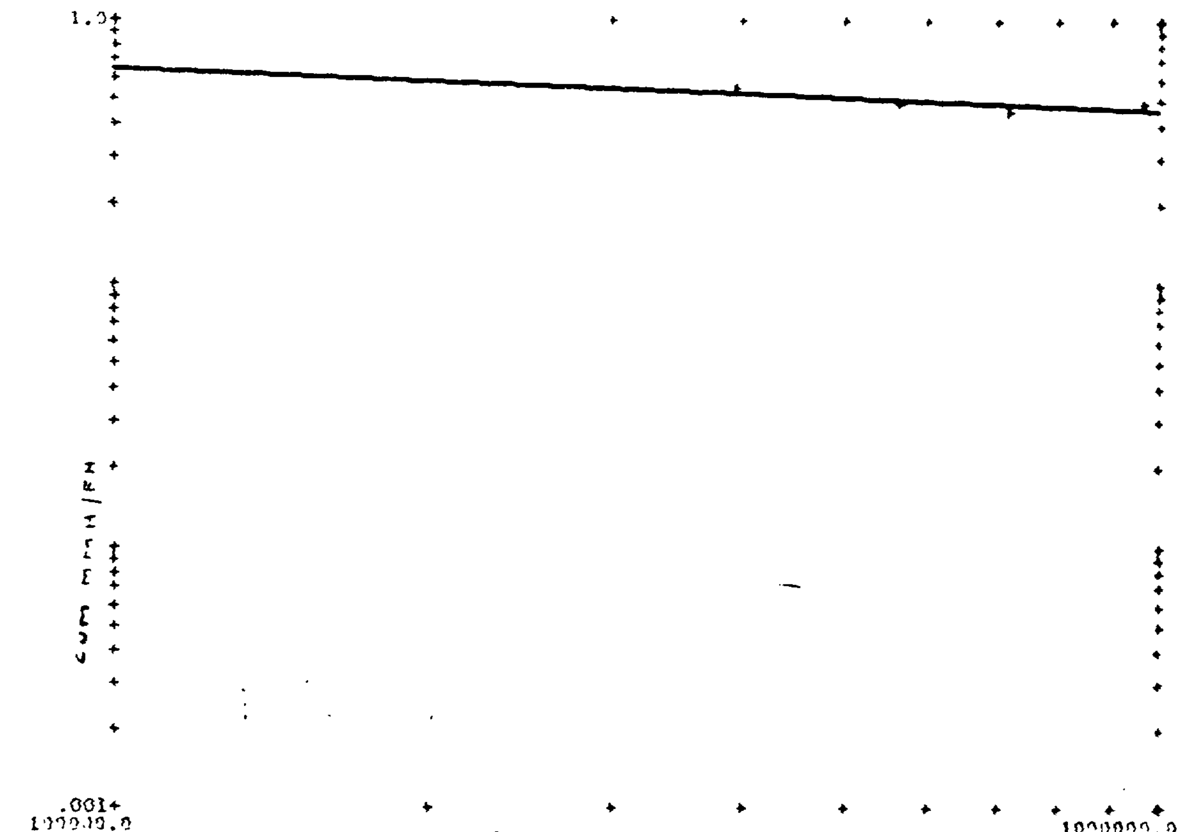
PREPARED BY
CHECKED BY
DATE

INCLUDES VIETNAM OPERATIONS



AIRFRAME
CH-46 MMH/FH - CUM

FIGURE 67



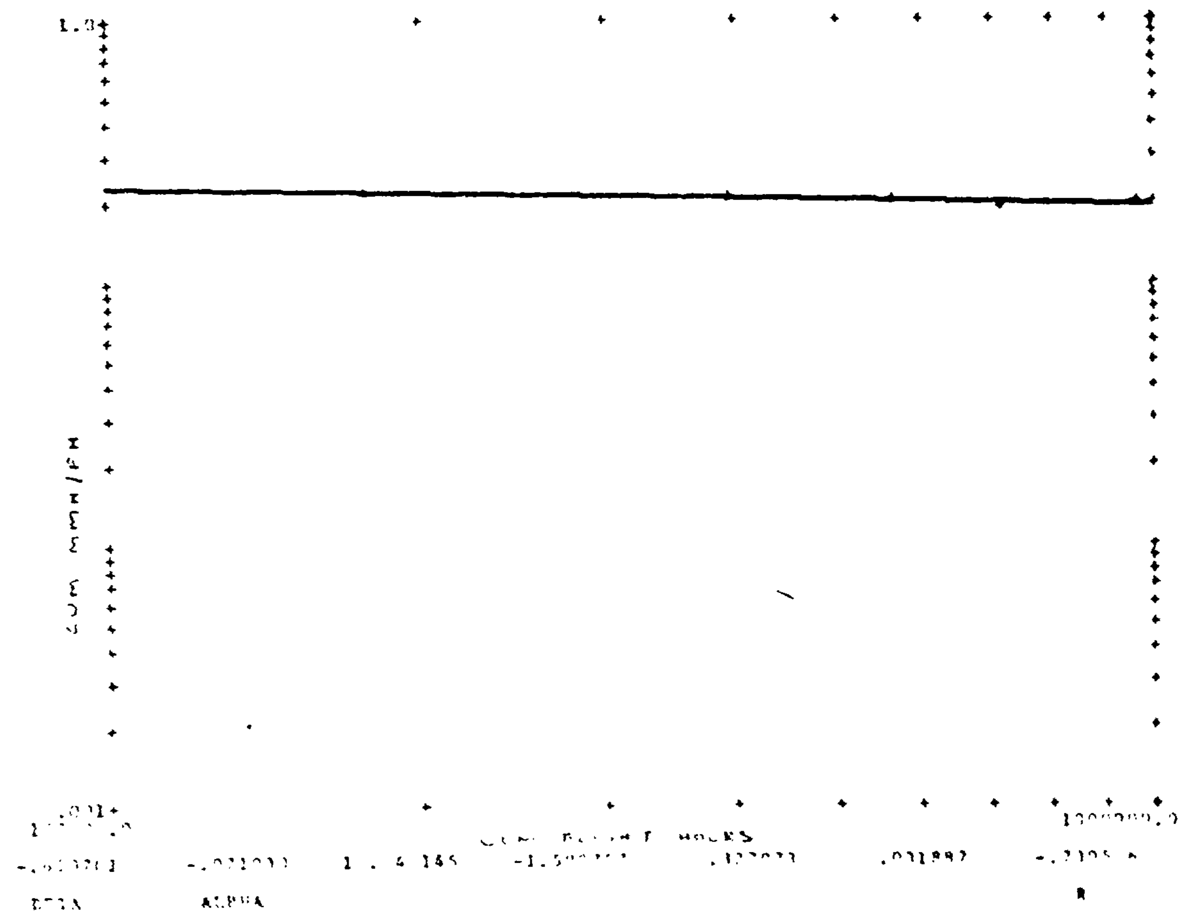
1.332977 -.148988 13.347145 -.755504 .17797 .069861 -.709604

BETA ALPHA R

ROTOR

CH-46 MMH/FH - CUM

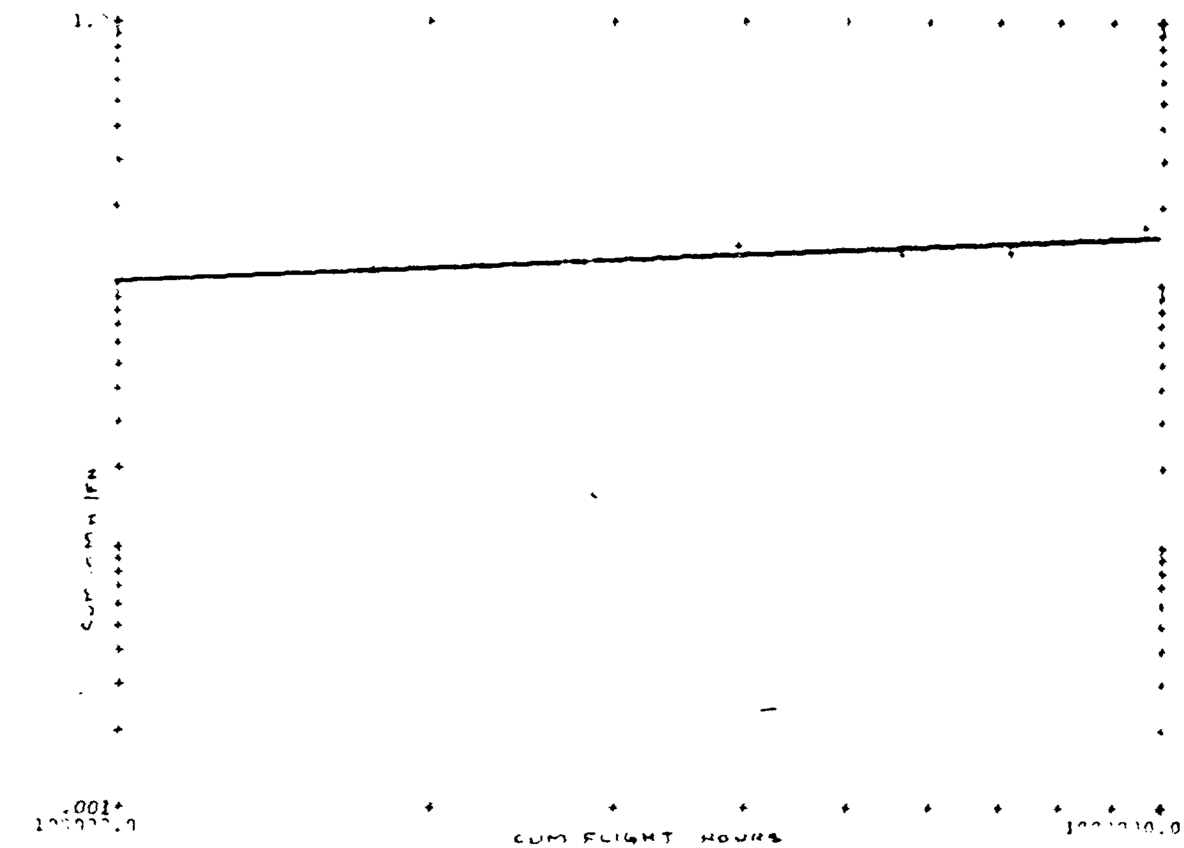
FIGURE 68



INSTRUMENT

CH-46 MMH/FH - CUM

FIGURE 69



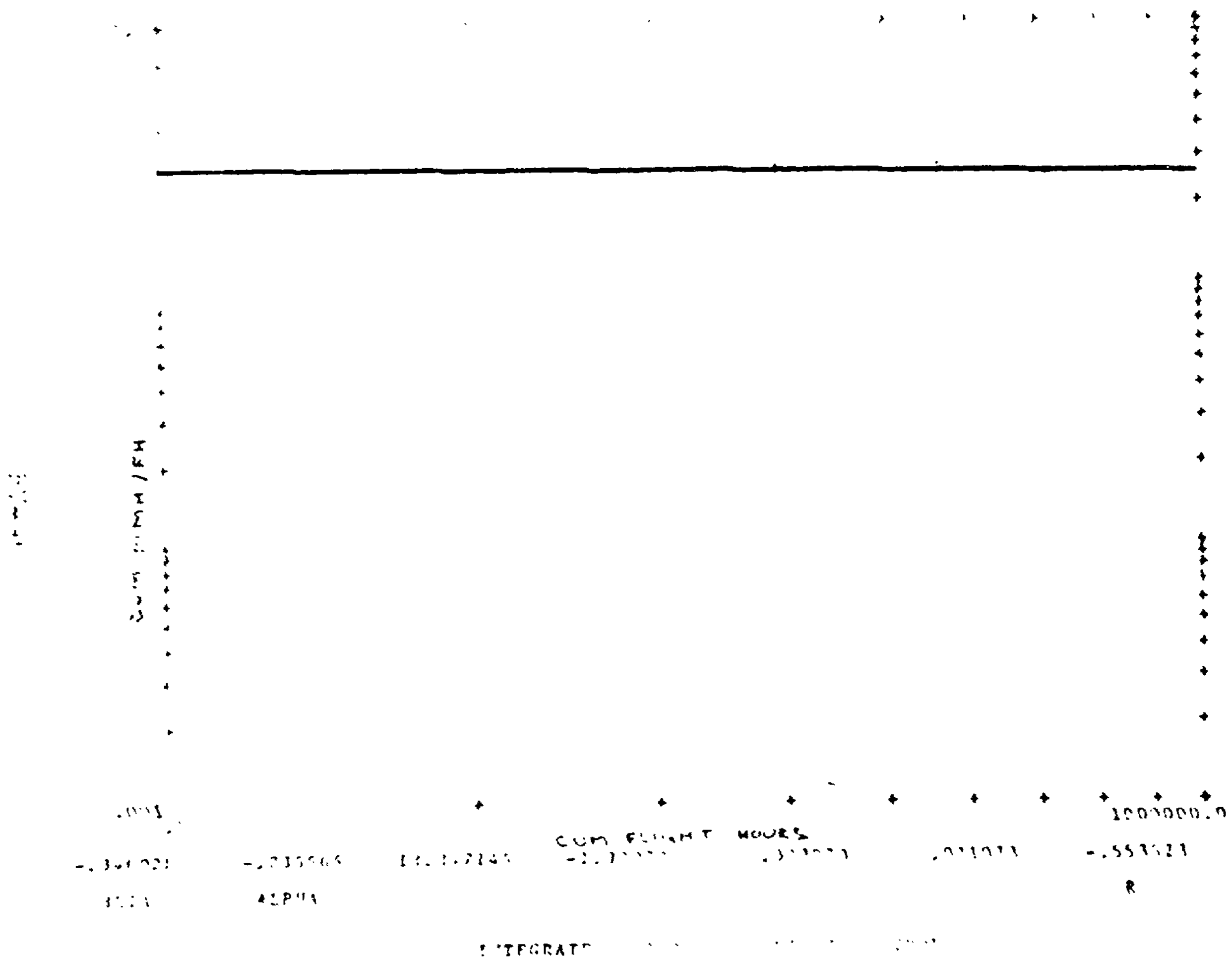
-4.23 ??7 .171446 11.347145 -1.040??? .????? .????? .616715

BETA ALPHA R

LANDING GEAR

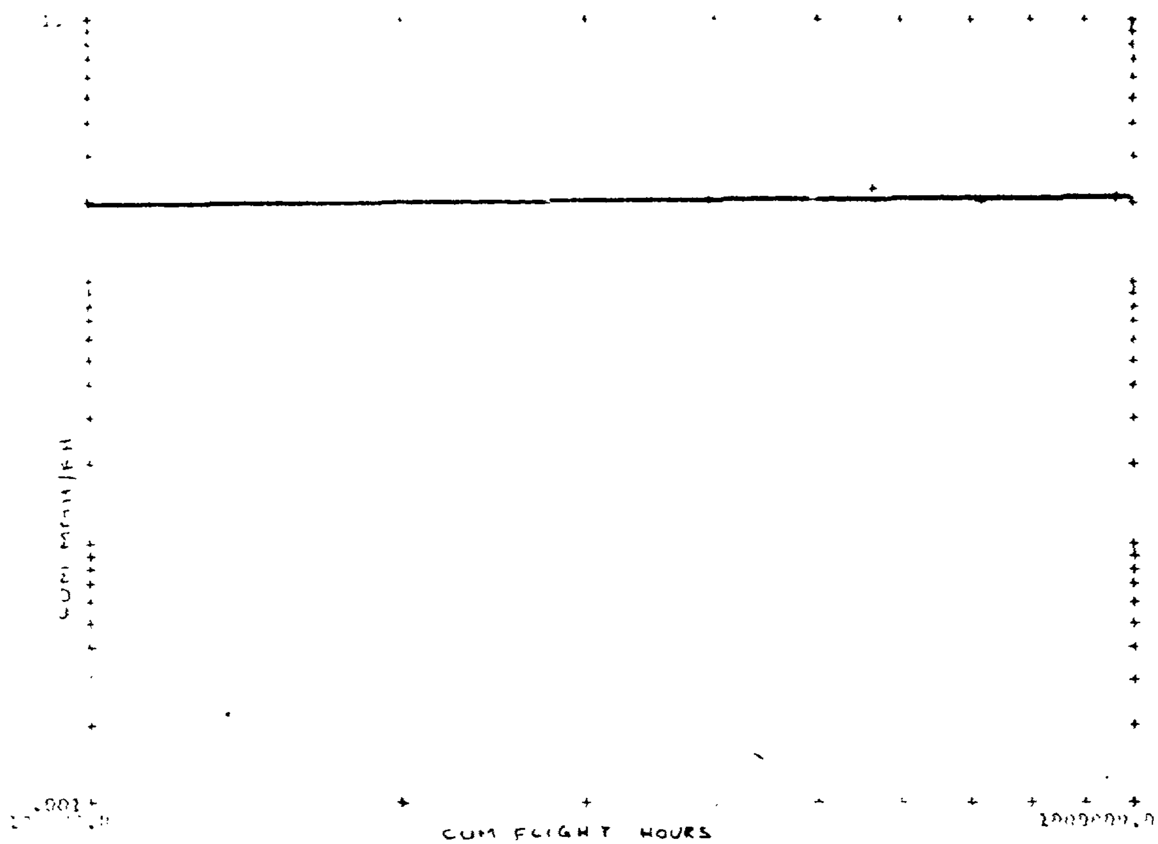
CH-46 MMH/FH - CUM

FIGURE 70



CH-46 MMH/FH - CUM

FIGURE 71

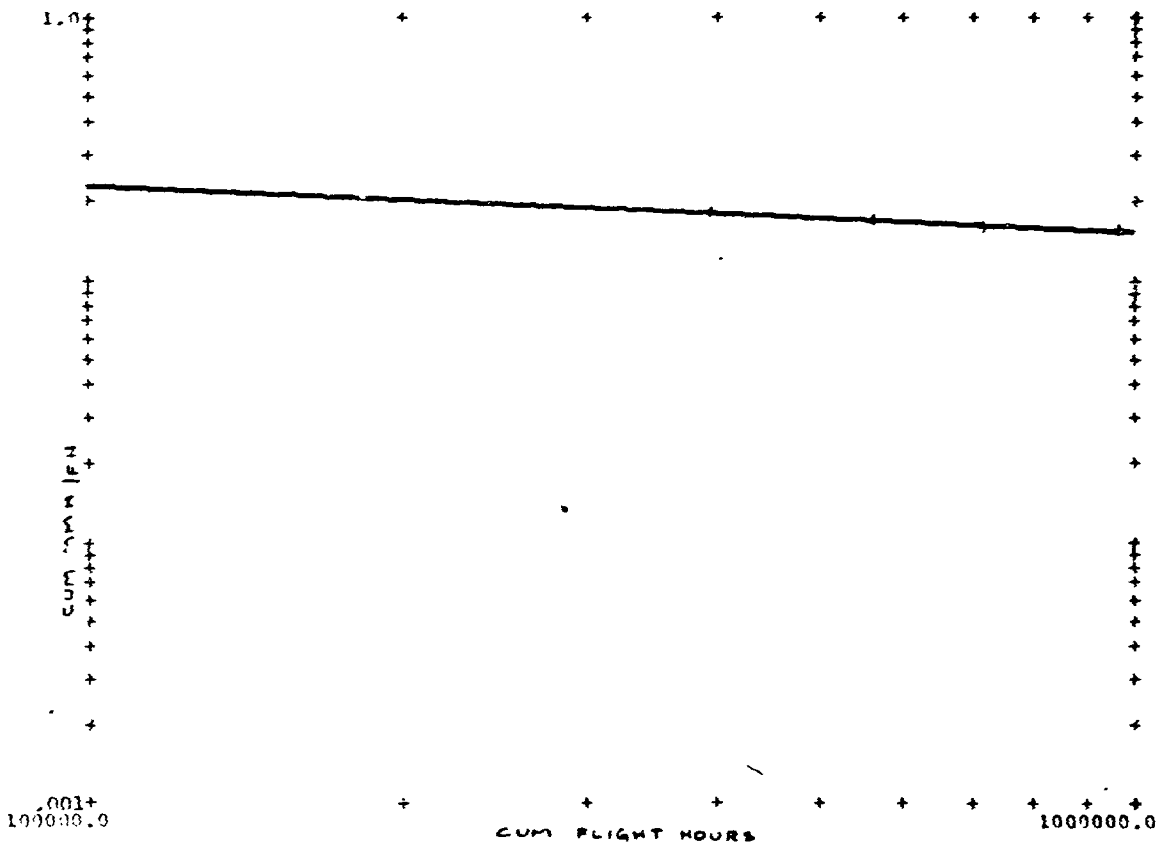


-1.072054	.030639	13.347145	-1.563093	.307073	.041706	.229447
BETA	ALPHA					R

FLIGHT CONTROLS

CH-46 MMH/FH - CUM

FIGURE 72

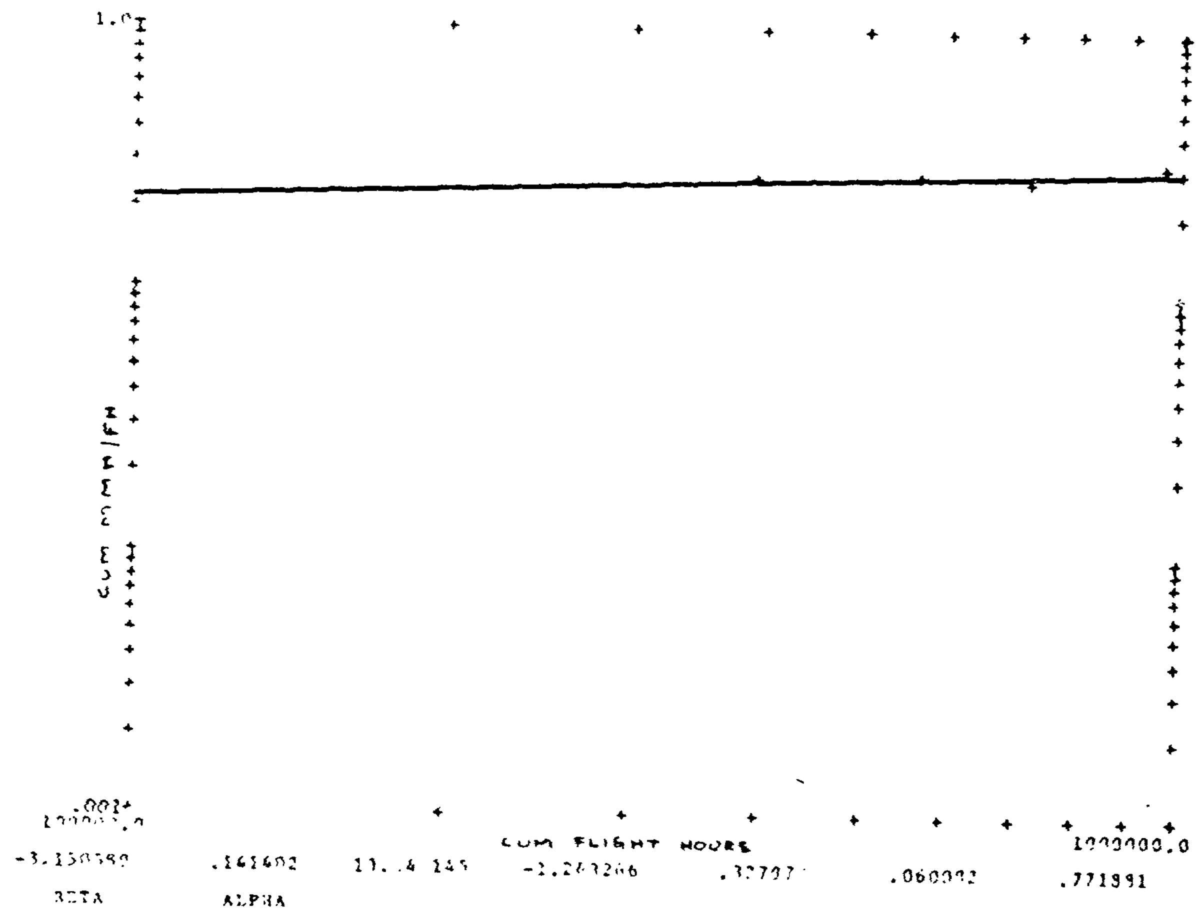


.519070	-.174832	1?.347145	-1.794459	.327973	.058064	-.937536
BETA	ALPHA					R

HYDRAULIC POWER SUPPLY

CH-46 MMH/FH - CUM

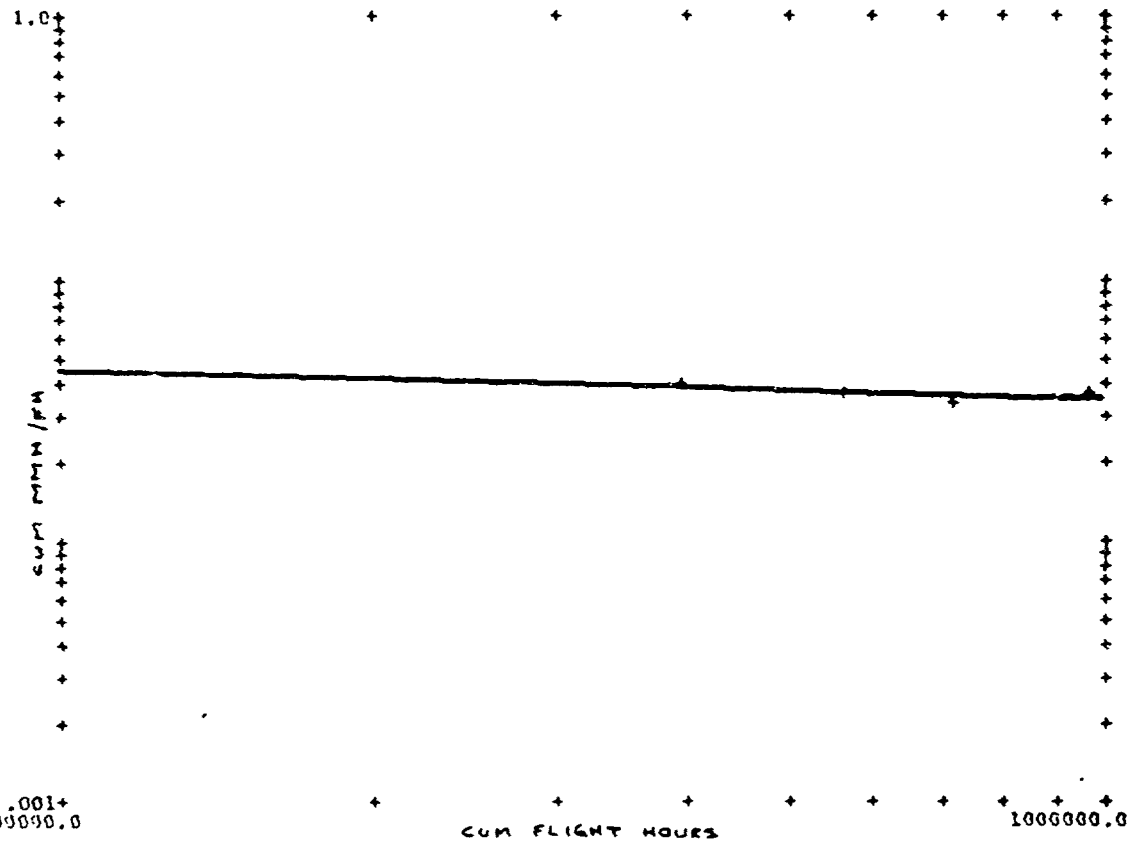
FIGURE 73



DRIVE

CH-46 MMH/FH - CUM

FIGURE 74



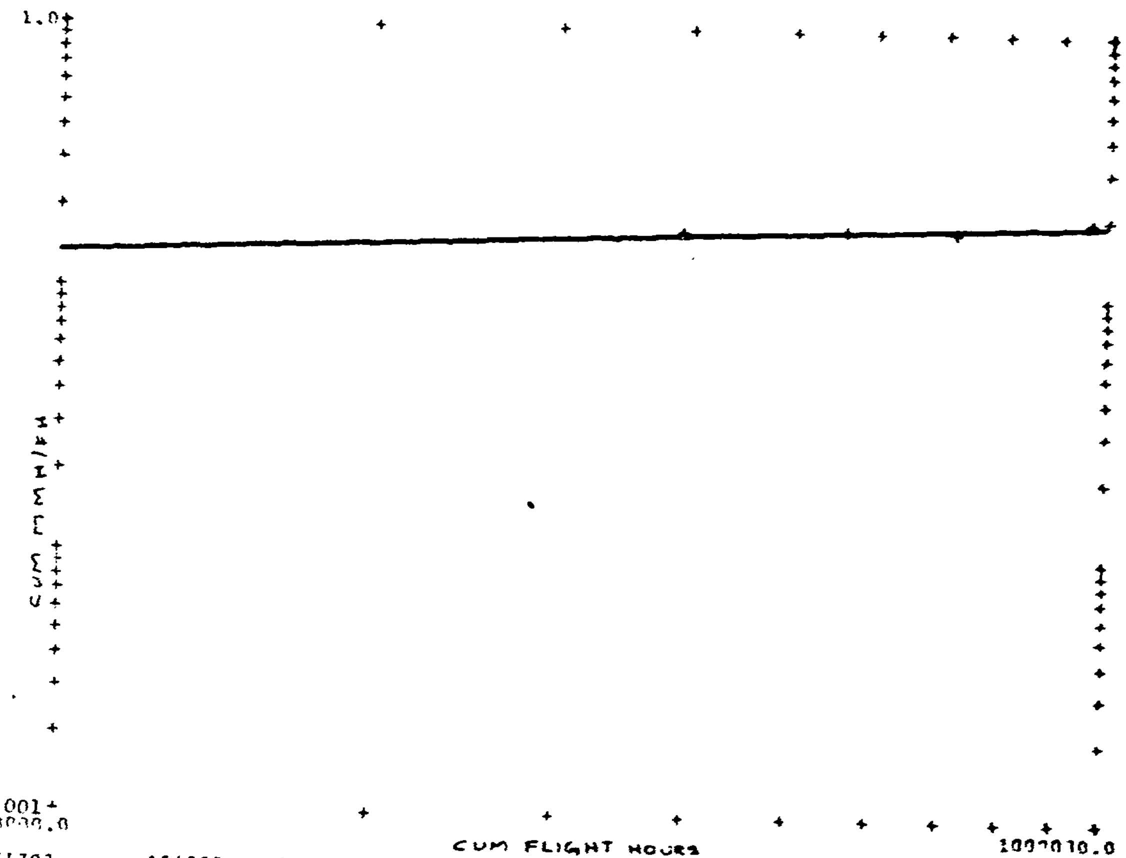
-1.823120 -.110681 13.347145 -3.298496 .327973 .057482 -.631501

BETA ALPHA R

LIGHTING

CH-46 MMH/FH - CUM

FIGURE 75



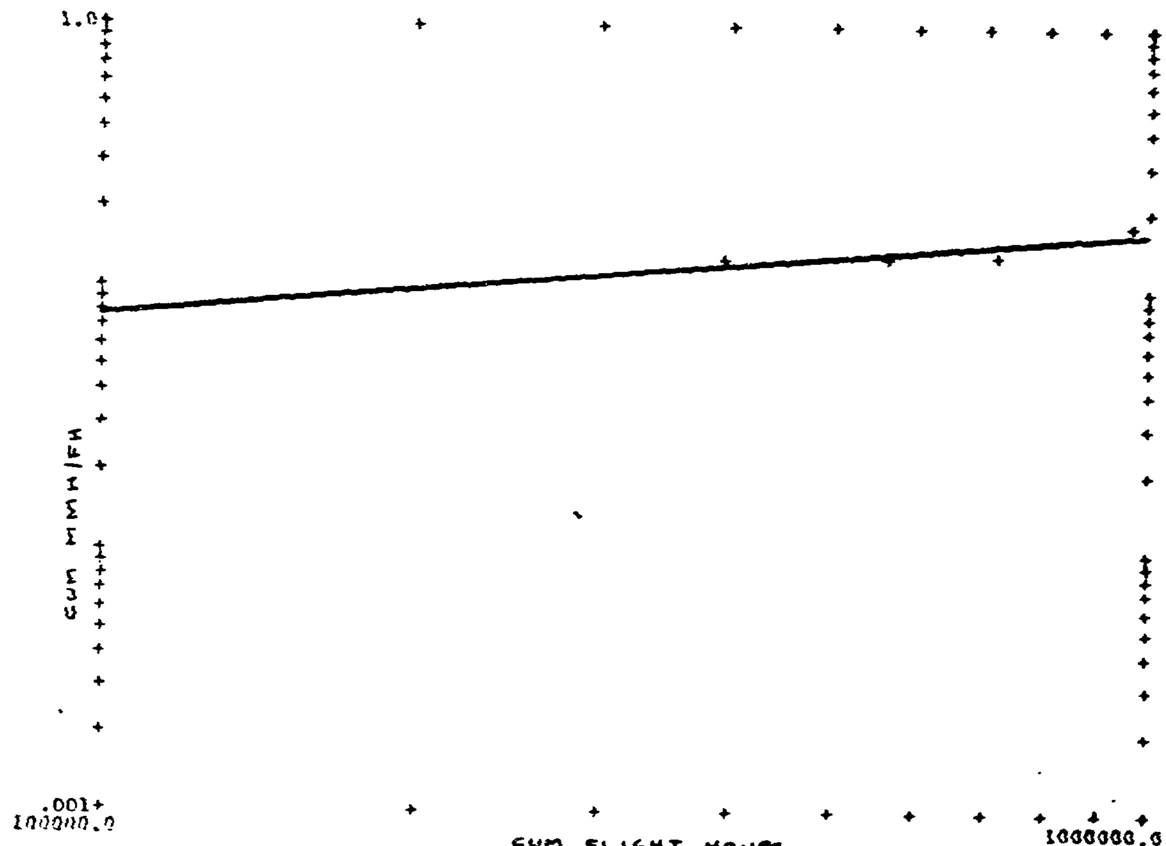
-3.771703 .154087 1 .347145 -1.7157 .1 973 .057:11 .581759

BETA ALPHA R

RADIO NAVIGATION

CH-46 MMH/FH - CUM

FIGURE 76

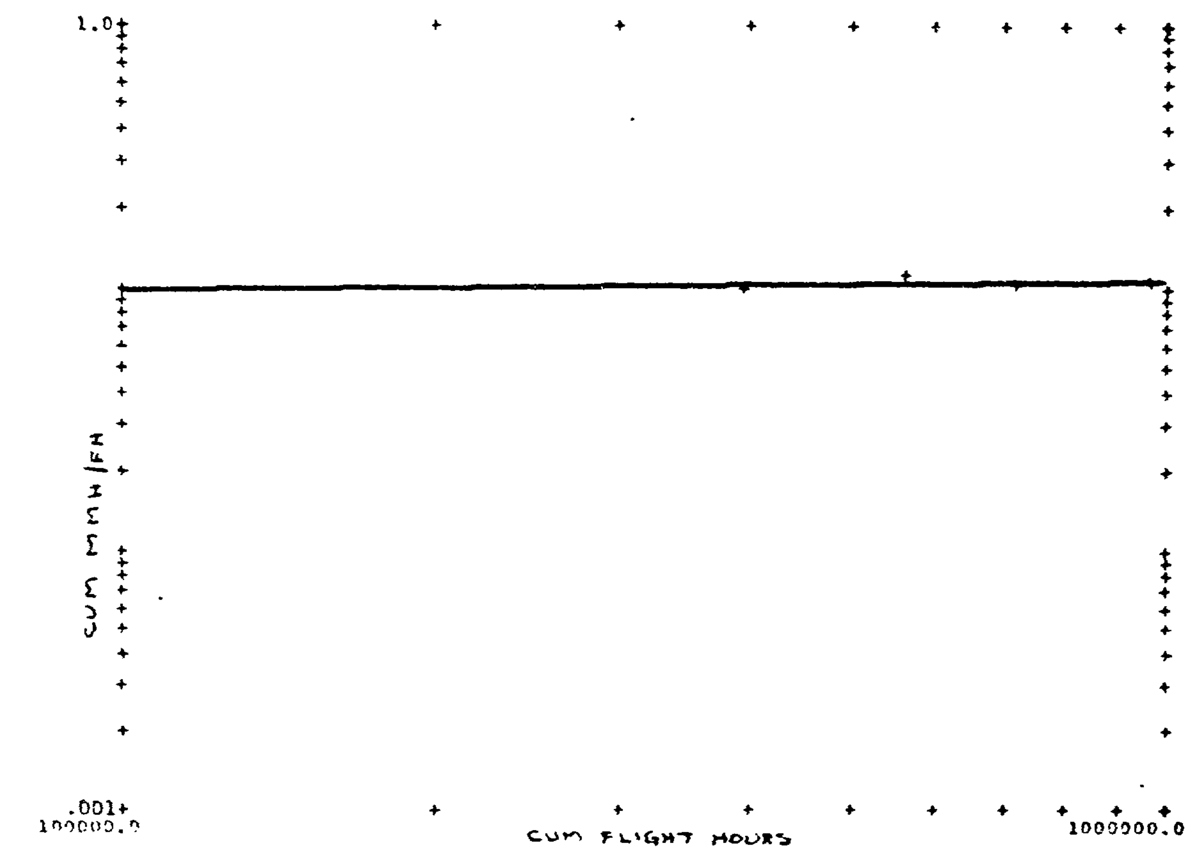


-6.343071	.329663	13.347145	-1.963274	.327973	.129679	.833705
BETA	ALPHA					R

ELECTRICAL POWER SUPPLY

CH-46 MMH/FH - CUM

FIGURE 77



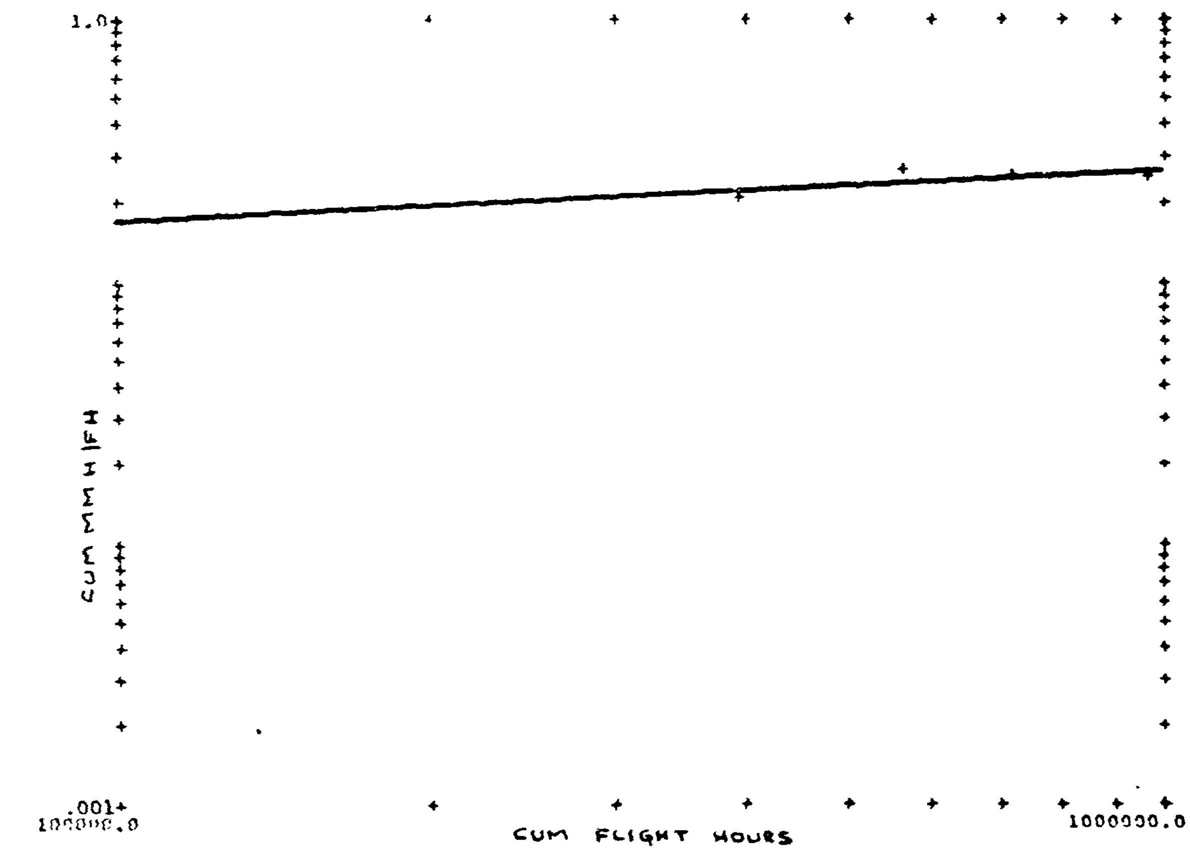
-2.733910 .040926 1?.347143 -2.247?? .327973 .044166 .38.911

BETA ALPHA R

POWERPLANT INSTALLATION

CH-46 MMH/FH - CUM

FIGURE 7B



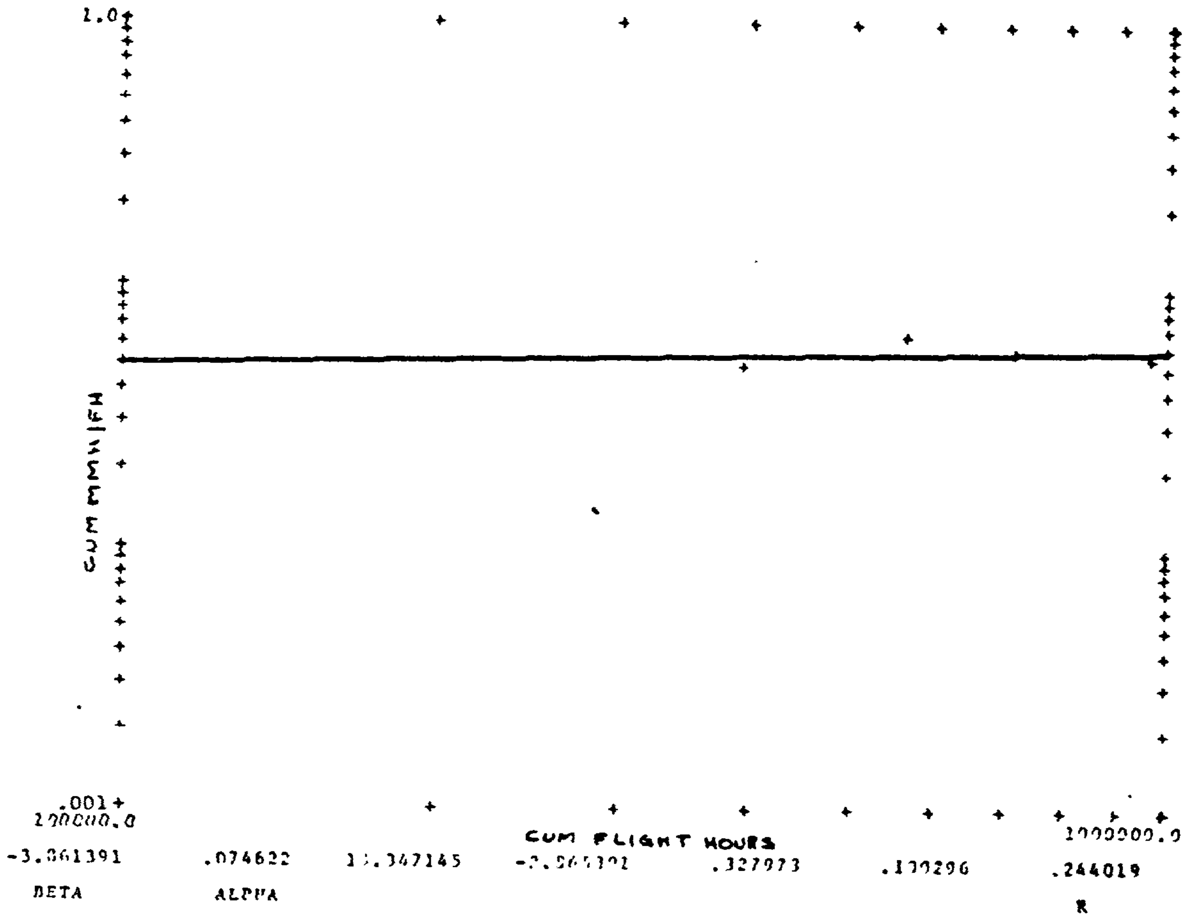
-3.990578 .19 997 13. 4 145 -1.402603 .372973 .093519 .679999

BETA ALPHA R

TURBOSHAFT ENGINES

CH-46 MMH/FH - CUM

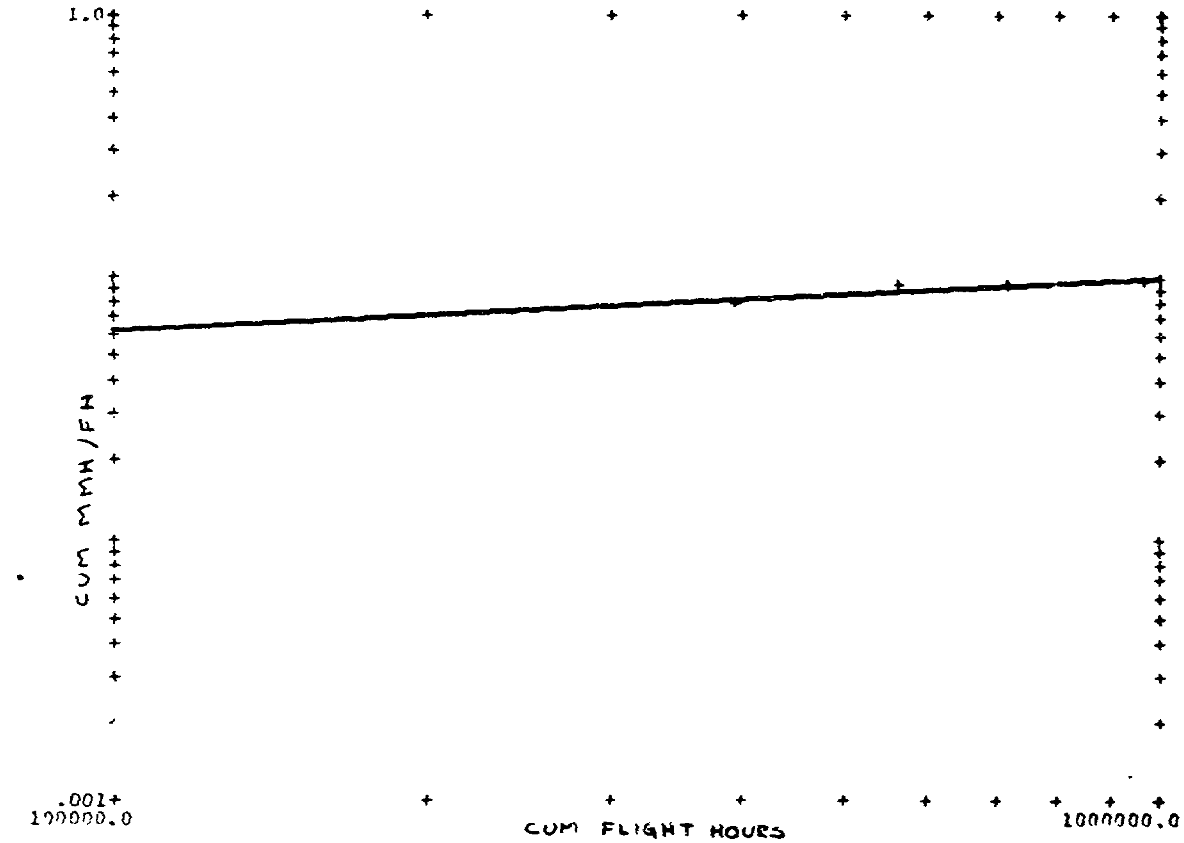
FIGURE 79



INTERPHONE

CH-46 MMH/FH - CUM

FIGURE 80



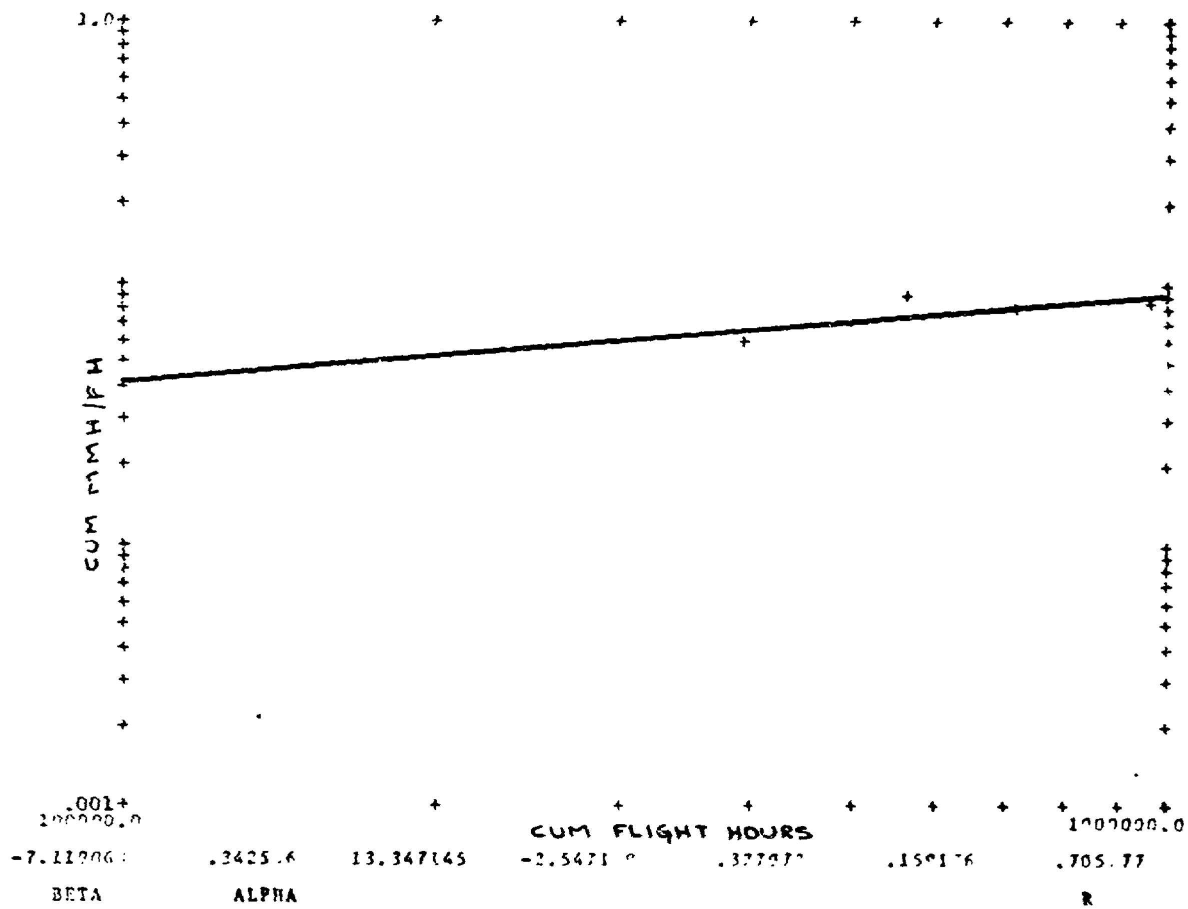
-5.232423 .204950 2[illegible]347245 -2.[illegible] .[illegible]22[illegible]73 .97346[illegible] .877236

BETA ALPHA R

[illegible] COMMUNICATIONS

CH-46 MMH/FH - CUM

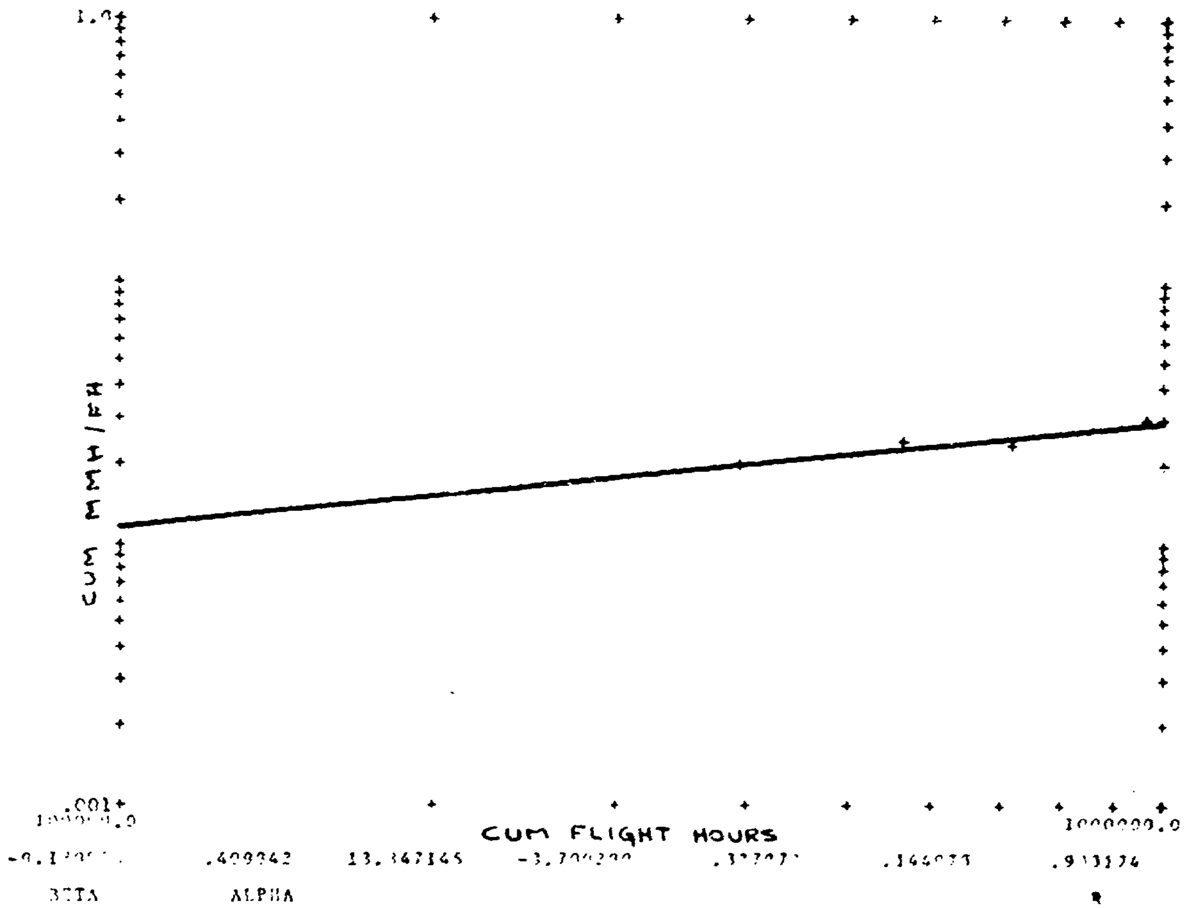
FIGURE 81



HF COMMUNICATIONS

CH-46 MMH/FH - CUM

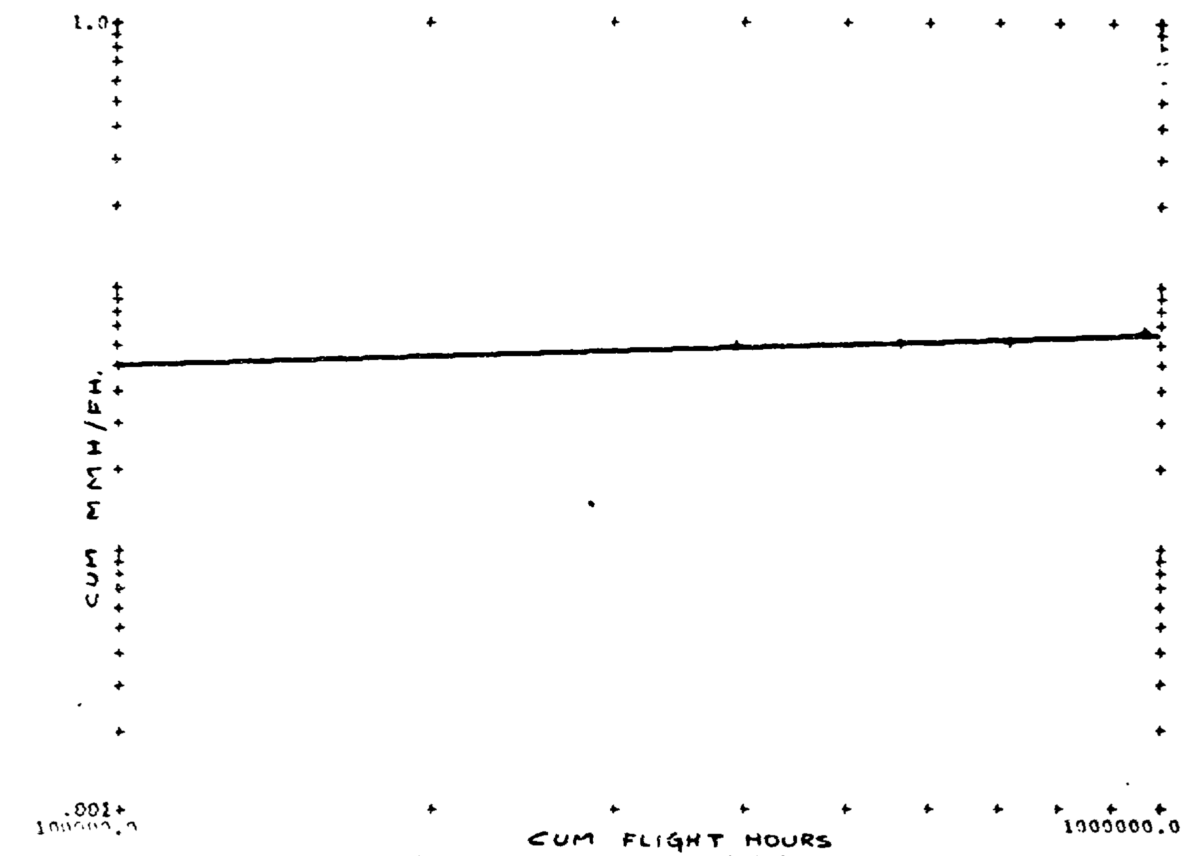
FIGURE 82



FUSELAGE COMPARTMENT

CH-46 MMH/FH - CUM

FIGURE 83



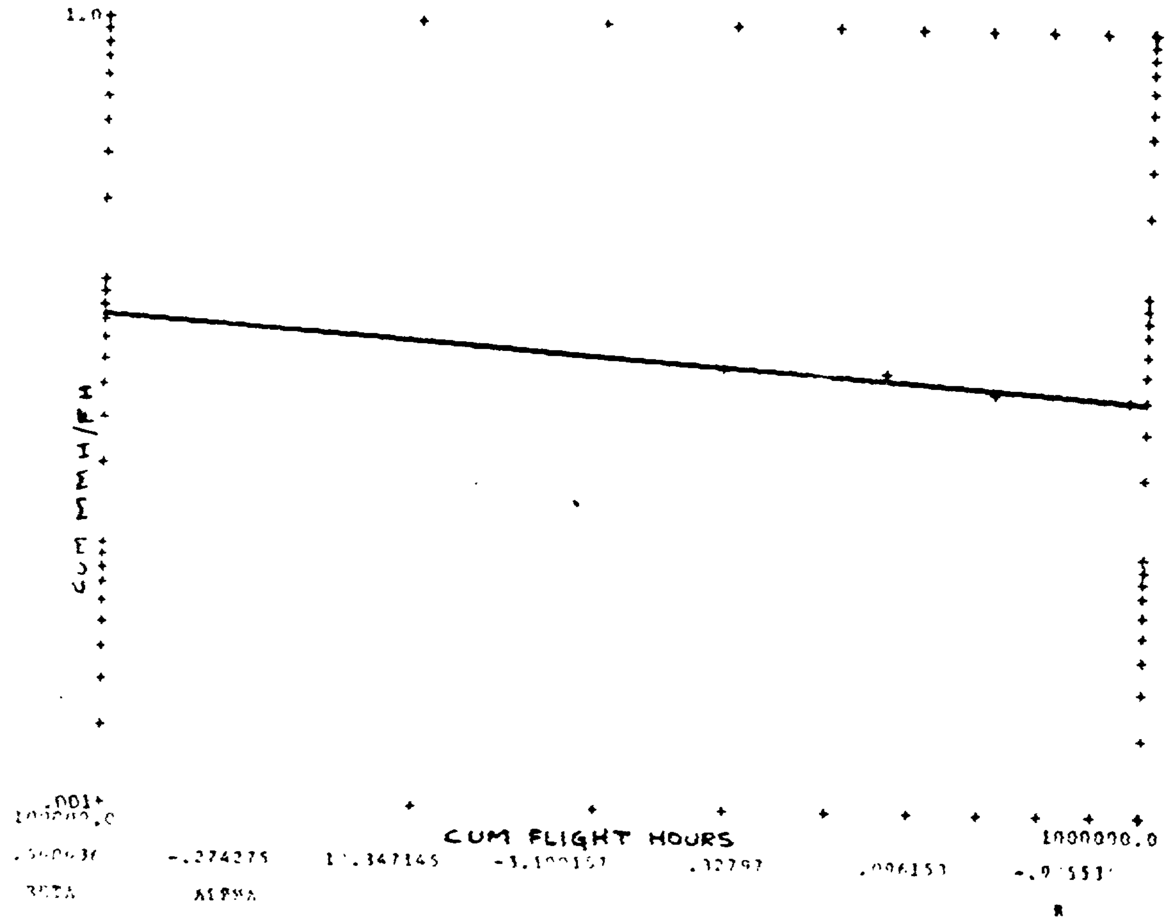
-4.3.6031 .11?069 1?.347145 -2.72?693 .32?97? .04?283 .90004?

BETA ALPHA R

AUX. POWERPLANT

CH-46 MMH/FH - CUM

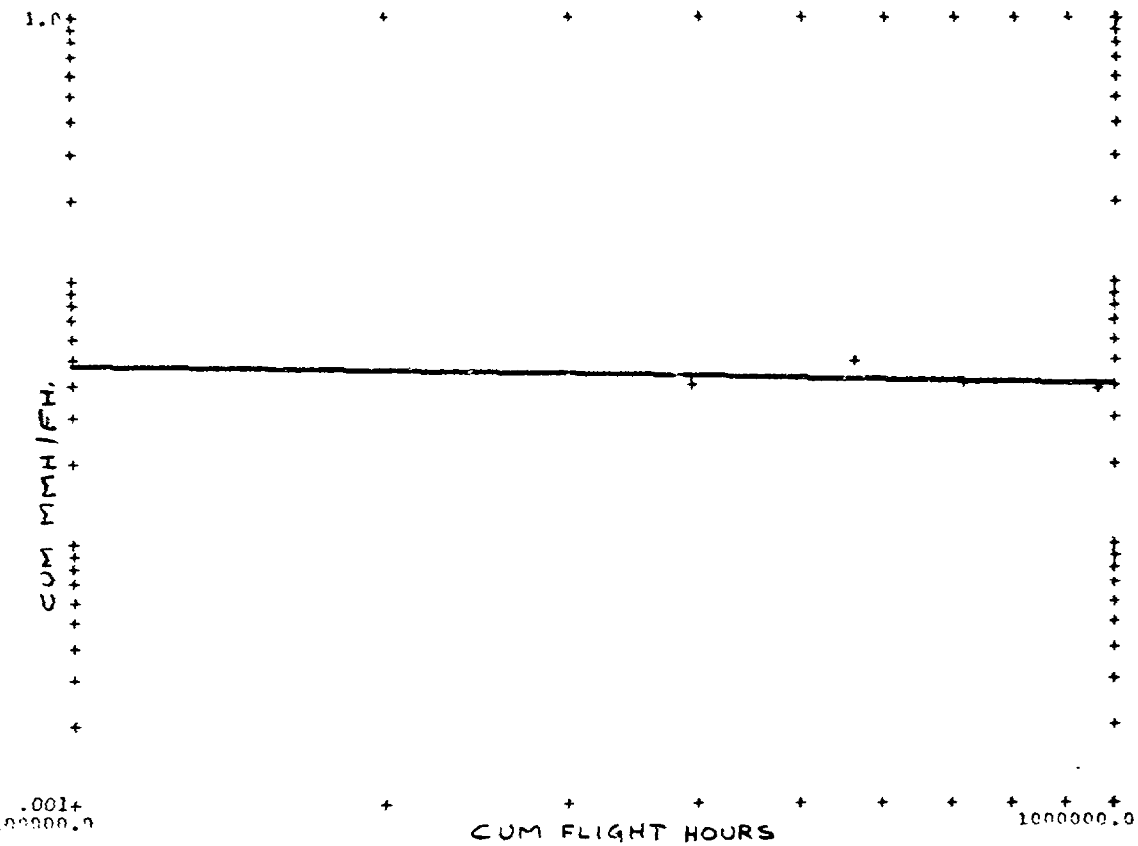
FIGURE 84



IFF

CH-46 MMH/FH - CUM

FIGURE B5



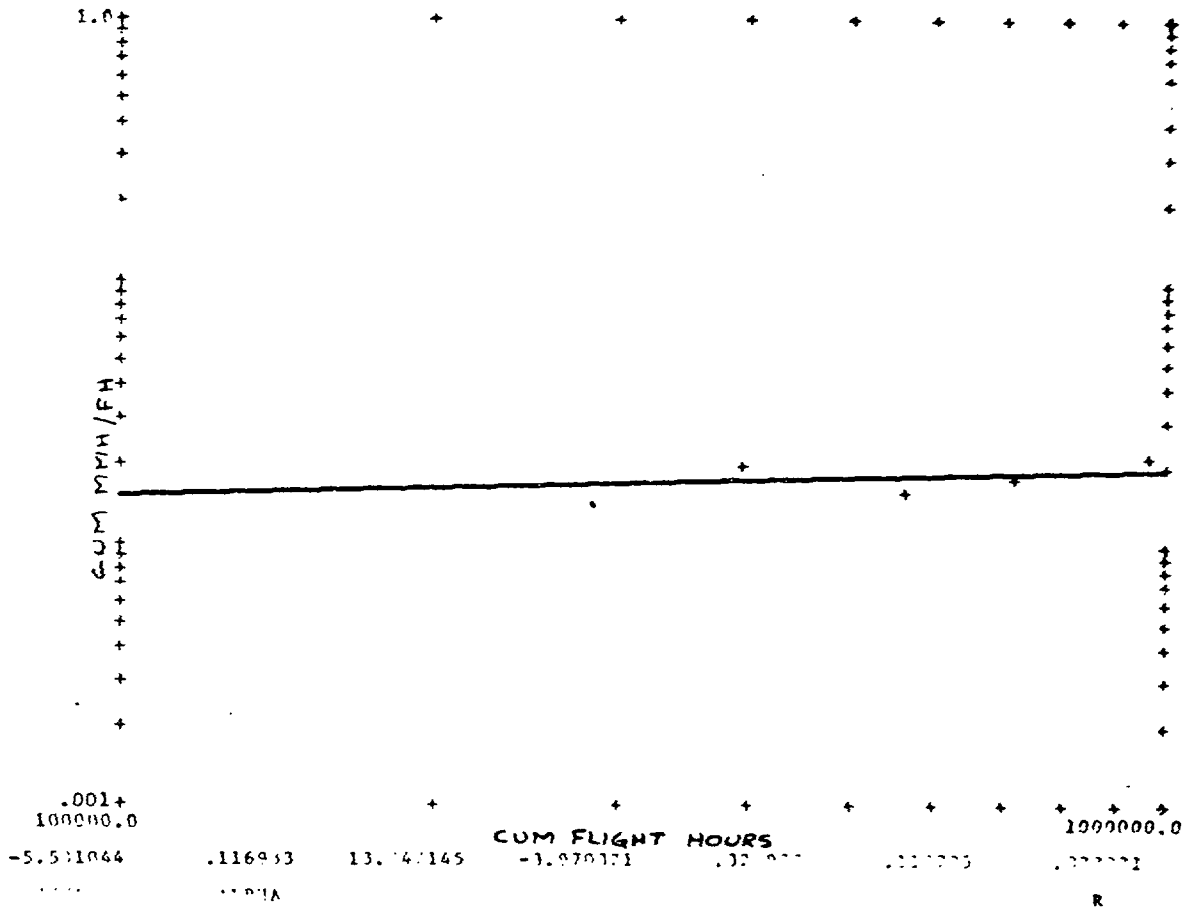
-2.269282 -.067356 13.347145 -3.168296 .327073 .089725 -.246206

BETA ALPHA R

RADAR NAVIGATION

CH-46 MMH/FH - CUM

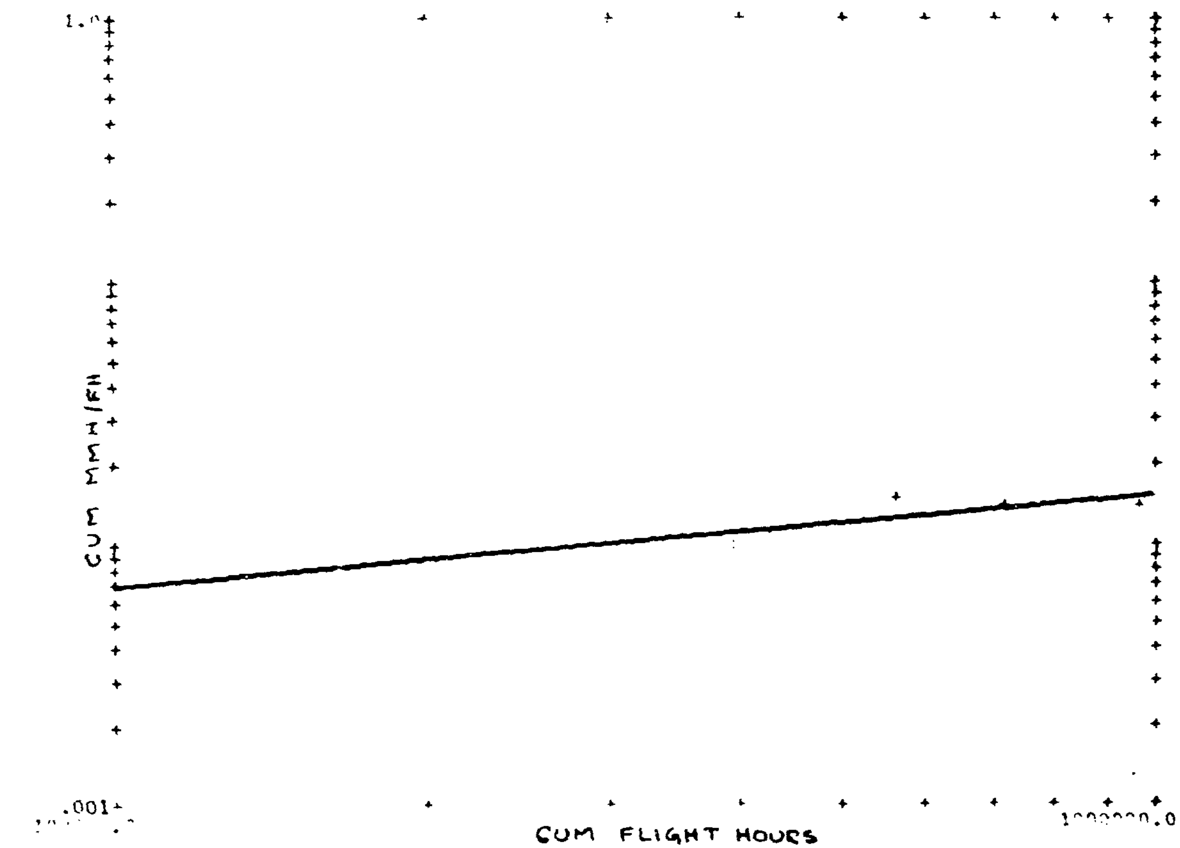
FIGURE 86



AIR CONDITIONING / ICE CONTROL

CH-46 MMH/FH - CUM

FIGURE 87

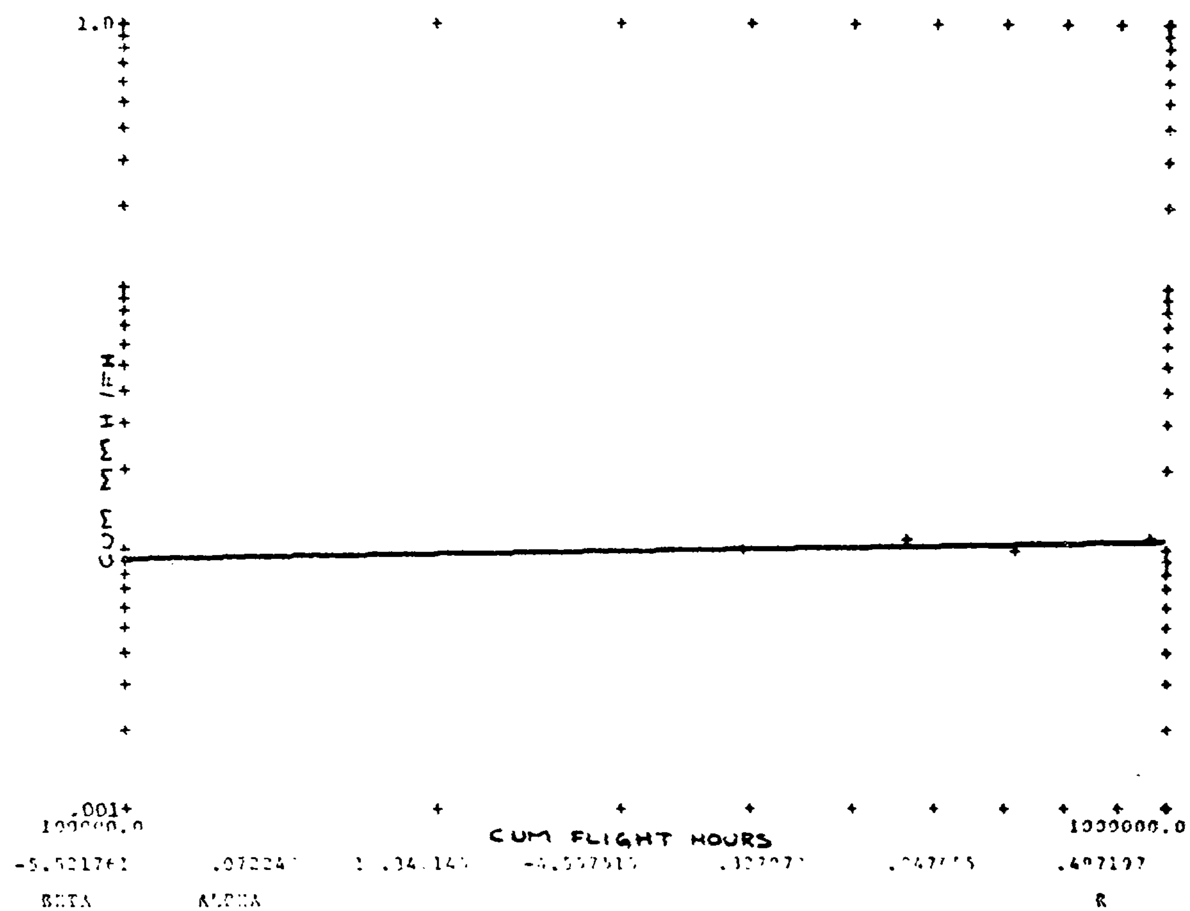


.346917 .158182 .715145

BETA ALPHA R

CH-46 MMH/FH - CUM

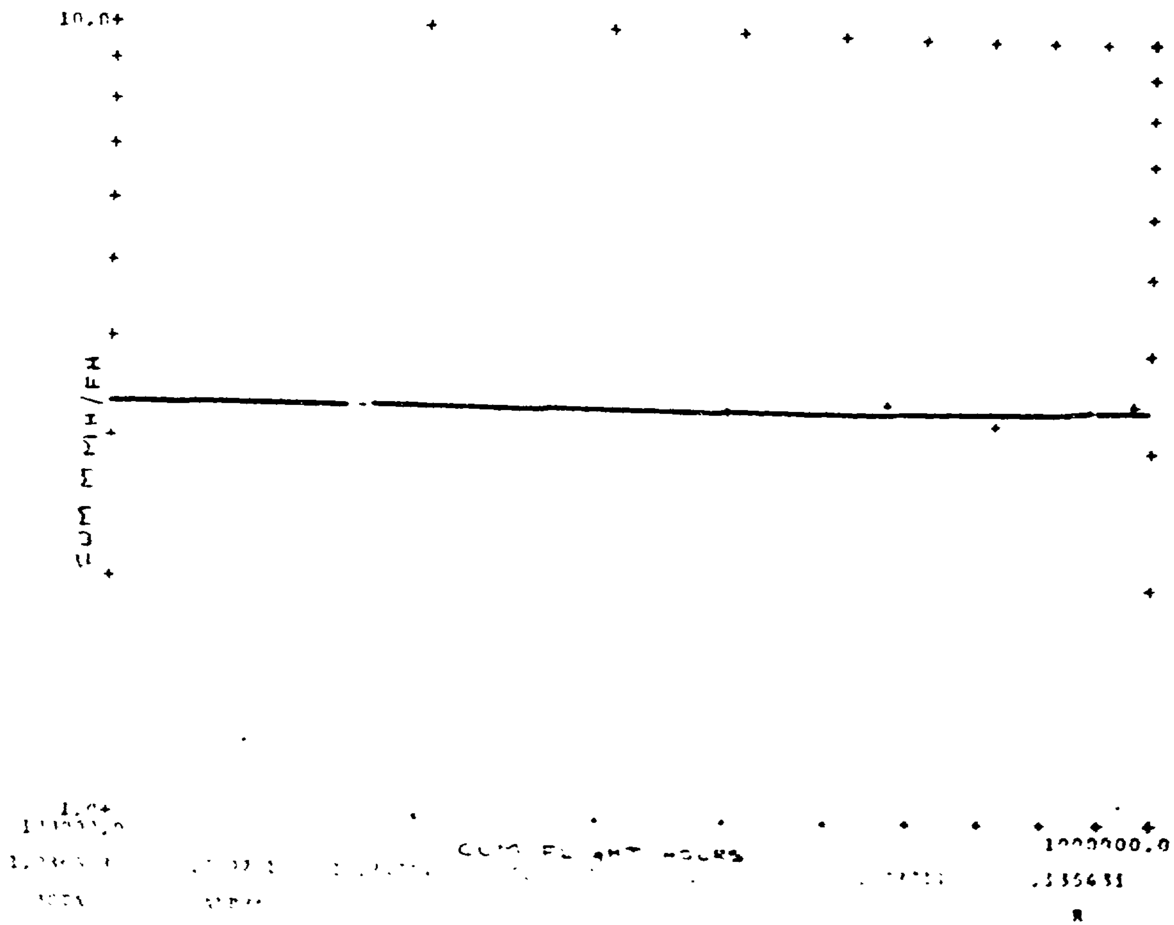
FIGURE 88



MISC. UTILITIES

CH-46 MMH/FH - CUM

FIGURE 89


10.0
CUM MMH/FH
1.0
1000000.0
.335631
R

PREPARED BY
CHECKED BY
DATE

TABLE 7 - CH-46 SYSTEM K & M GROWTH PARAMETERS

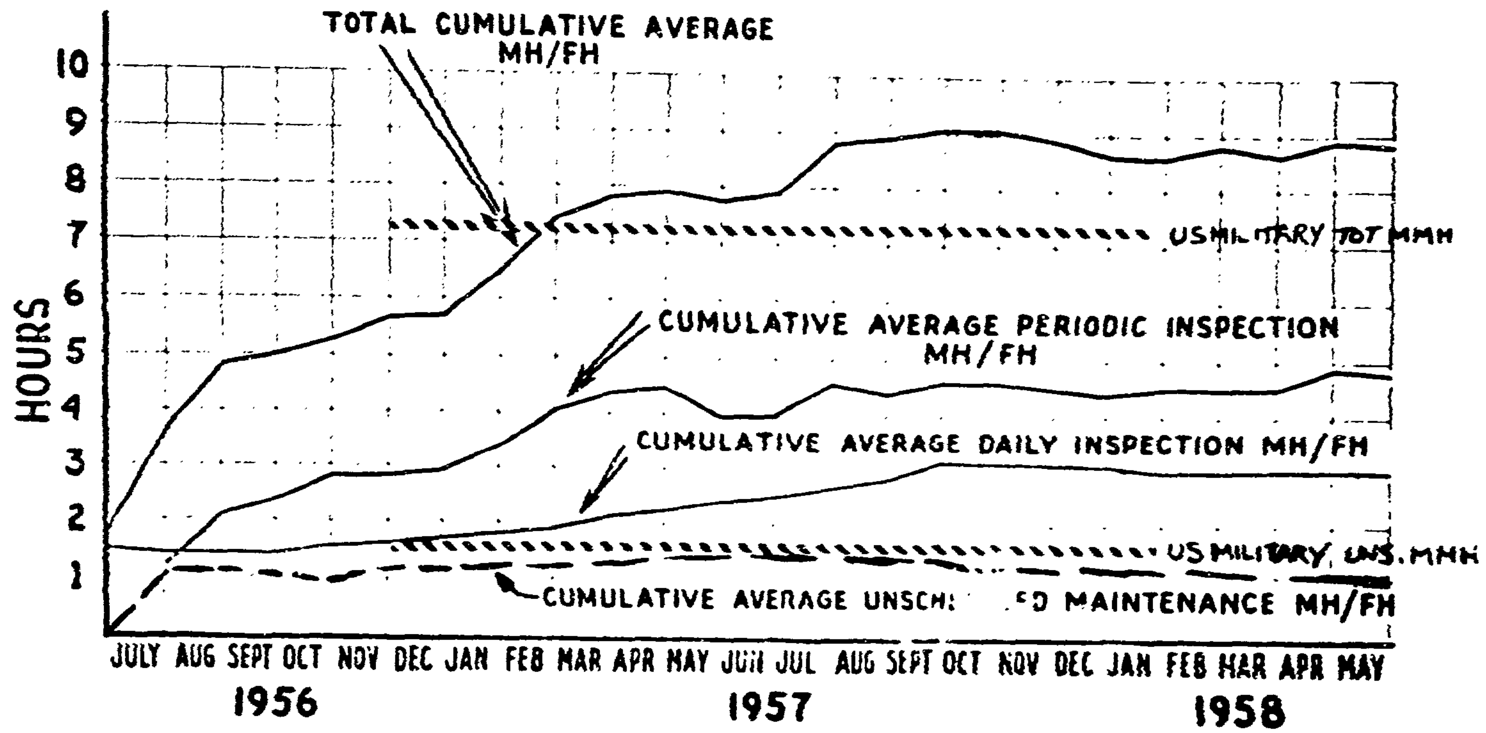
SYSTEM	MMH/FH - CUM			MAL/FH - CUM		
	β	α	R	β	α	R
AIRFRAME	3.011	-.288	-.954	2.889	-.372	-.950
ROTOR	1.283	-.149	-.710	-4.551	.152	.708
INSTRUMENT	-.651	-.031	-.731	-1.481	-.009	-.772
LANDING GEAR	-4.238	.171	.617	-4.159	.005	.410
INTEGRATED GUID & FLIGHT CONTROL	-.846	-.036	-.954	-4.754	.130	.977
FLIGHT CONTROLS	-1.973	.031	.229	-4.162	.007	.606
HYDRAULIC POWER SUPPLY	.539	-.175	-.988	-2.597	-.058	-.433
DRIVE	-3.151	.141	.772	-8.285	.363	.843
LIGHTING	-1.821	-.111	-.632	-1.521	-.165	-.708
RADIO NAVIGATION	3.172	[illegible]	.86[illegible]	-9.825	.476	.975
ELECTRICAL POWER SUPPLY	[illegible]	.330	[illegible]	-7.754	.302	.728
POWERPLANT INSTL	[illegible]	[illegible]	[illegible]	-8.348	.309	.951
TURBOSHAFT ENGINES	-1.991	.194	.680	-4.118	.012	.852
INTERPHONE	-3.561	.075	.244	-.783	-.249	-.889
UHF COMMUNICATION	-5.[illegible]2	[illegible]	[illegible]	-6.354	.169	.873
HF COMMUNICATION	-[illegible]19	.343	.706	-8.167	.249	.567
FUSELAGE COMPART.	[illegible]	.410	[illegible]	-10.898	.494	.888
AUX POWERPLANT	[illegible]	[illegible]17	[illegible]	-5.649	.087	.649
IFF	.561	-.274	-.116	-.572	-.318	-.859
RADAR NAVIGATION	-2.269	-.0[illegible]7	-.246	-2.321	-.184	-.875
AIR COND & ICE CONTROL	-2.571	[illegible]	.323	-4.366	-.063	-.194
FUEL	-4.9[illegible]	.345	[illegible]	-5.298	-.000	-.001
MISC UTILITIES	-5.5[illegible]2	.072	.497	-13.93	.597	.873
TOTAL	.987	.010	.155	2.639	.218	-.985

NUMBER
REV LTR

SHEET

FIGURE 91

H-21 - BELOW DEPOT MAINTENANCE MAN-HOURS FRENCH ARMY- SETIF, ALGERIA



[illegible] XMSN [illegible] GROWTH STATISTICS
UNSCHEDULED REMOVALS PER 1000 FLIGHT HOURS

FORWARD XMSN (114D1001)					AFT XMSN (114D2001)					COMBINING XMSN (114D5001)					ENGINE XMSN (114D[illegible])				
CUM FLIGHT HOURS	YEAR	λ	CUM λ	DASH NO.	CUM FLIGHT HOURS	YEAR	λ	CUM λ	DASH NO.	CUM FLIGHT HOURS	YEAR	λ	CUM λ	DASH NO.	CUM FLIGHT HOURS	YEAR	λ	CUM λ	DASH NO.
[illegible]	[illegible]	.25	3.26	-4	[illegible]	1963	.16	.16	[illegible]	[illegible]	1163	.85	.85	-9	[illegible]	1963	[illegible]	1.10	-6
12353	[illegible]	[illegible]	3.12	6	[illegible]	1964	.41	.71	-9	[illegible]	[illegible]	[illegible]	1.57	[illegible]	[illegible]	[illegible]	[illegible]	.64	-7
[illegible]	[illegible]	1.20	2.68	-20	[illegible]	1964	.6	.62	[illegible]	[illegible]	1163	[illegible]	2.14	-4	[illegible]	[illegible]	[illegible]	.17	[illegible]
[illegible]	1965	.42	1.90	-21	[illegible]	[illegible]	.46	.66	[illegible]	[illegible]	[illegible]	[illegible]	.16	[illegible]	[illegible]	[illegible]	[illegible]	.12	[illegible]
60564	[illegible]	1.55	1.68	-22	[illegible]	[illegible]	.17	.16	[illegible]	[illegible]	[illegible]	[illegible]	1.16	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
72686	1966	.62	1.54	-23	[illegible]	[illegible]	[illegible]	.40	[illegible]	[illegible]	1965	[illegible]	1.16	[illegible]	[illegible]	[illegible]	[illegible]	.28	[illegible]
171313	1967	.78	.61	-25	[illegible]	[illegible]	.16	.41	[illegible]	[illegible]	1966	1.15	1.41	[illegible]	[illegible]	[illegible]	[illegible]	.19	[illegible]
271836	1967	.16	.67	-26	[illegible]	[illegible]	[illegible]	.65	[illegible]	[illegible]	1966	[illegible]	1.33	[illegible]	[illegible]	1966	[illegible]	.7	[illegible]
734000	1972	.73	.72	-27	[illegible]	1966	[illegible]	.58	[illegible]	[illegible]	[illegible]	[illegible]	.97	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
789000	1974	.42	.70	-30	[illegible]	1966	.22	.51	[illegible]	[illegible]	[illegible]	[illegible]	.67	[illegible]	[illegible]	[illegible]	[illegible]	.66	[illegible]
					734000	1972	.58	.57	-26	734000	1972	.27	.39	-20	[illegible]	[illegible]	[illegible]	.53	[illegible]
					789000	1974	.29	[illegible]	-30	789000	1974	.27	[illegible]	-21	[illegible]	[illegible]	[illegible]	.41	[illegible]
															734000	1972	1.02	1.16	-20
															789000	1974	.97	1.15	-20

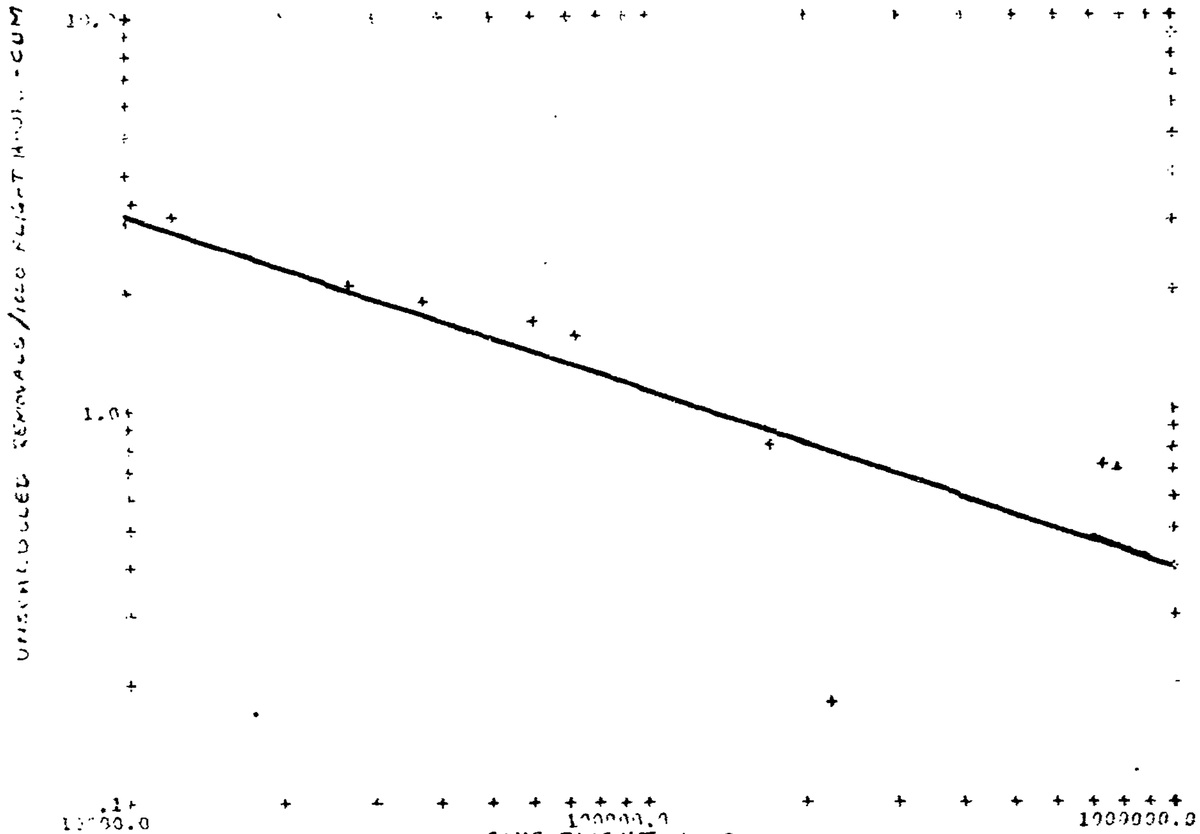
*** Bo[illegible] ***

TABLE 6

TABLE 9 - CH-47 COMPONENT λ GROWTH STATISTICS

UNSCHEDULED REMOVALS PER 1000 FLIGHT HOURS

CUM FLIGHT HOURS	COMPONENT YEAR	N1 ACTUATOR λ	N1 ACTUATOR CUM λ	N1 ACTUATOR λ	N1 ACTUATOR CUM λ	PIVOTING ACTUATOR λ	PIVOTING ACTUATOR CUM λ	SWIVELING ACTUATOR λ	SWIVELING ACTUATOR CUM λ	ROTOR BLADES λ	ROTOR BLADES CUM λ	SWASHPLATE λ	SWASHPLATE CUM λ	HYDRAULIC PUMP λ	HYDRAULIC PUMP CUM λ	CYCLIC TRIM ACTUATOR λ	CYCLIC TRIM ACTUATOR CUM λ
37033	1965	.75	.75	1.10	1.10	1.60	1.50	1.40	1.40	.80	.80						
[illegible]	[illegible]					4.98	3.17	[illegible]	2.68	1.45	1.12	.85	85			.90	.90
108340	[illegible]	.70	.72			1.90	[illegible]	[illegible]	2.42					.60	60	.80	.87
194000	1967	70	.71	.90	.96	1.15	2.07	1.25	1.94	.40	68	.80	.82				
[illegible]	[illegible]	6.71	[illegible]	1.68	[illegible]	.10	1.46	.70	1.36	.68	.65	.54	[illegible]	.56	[illegible]	1.12	1.04
[illegible]	[illegible]	2.19	[illegible]	.70	.57	.10	.12	.70	1.58	1.16	[illegible]	.72	.56	.34	.51	.66	.57
[illegible]	[illegible]	863	[illegible]	7.82	[illegible]	.24	.53	[illegible]	1.20	3.27	1.59	.49	[illegible]	.24	.42	.24	.66
[illegible]	72	130	4.05	[illegible]	2.66	.47	.15	.44	1.14	.20	1.47	.48	[illegible]	.71	.41	.96	.73

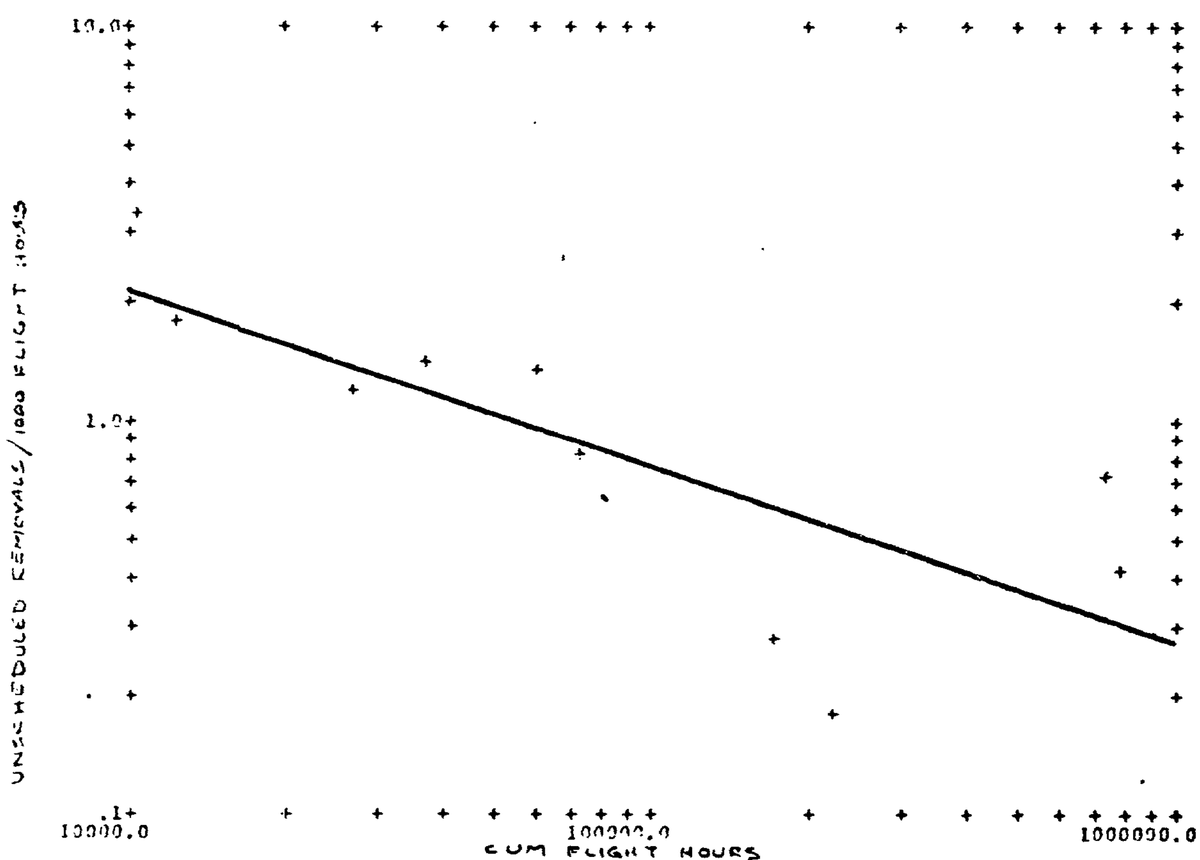


5.292694 -.449959 11.302819 .206080 1.458654 .835072 -.7 594?

BETA ALPHA n

FORWARD HSN 1140 001

FIGURE 92

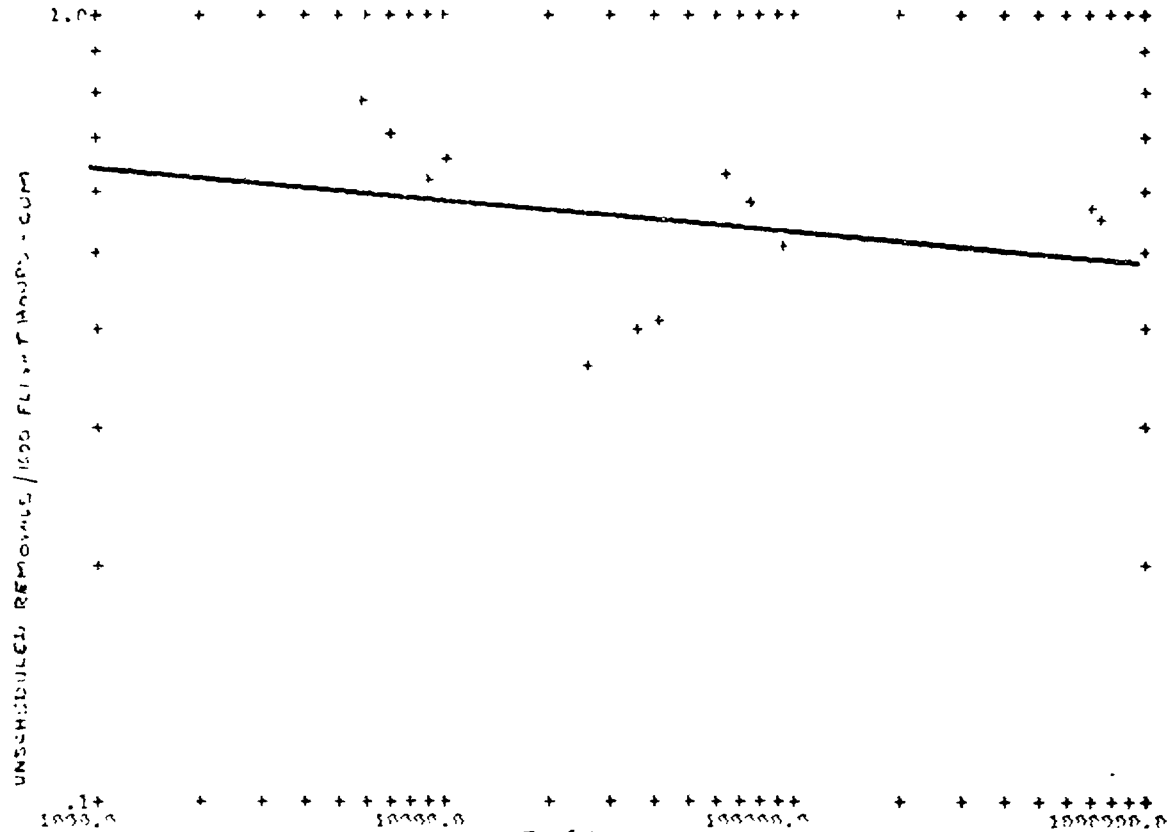


4.810499 -.446213 11.302819 -.177965 1.659654 .030162 -.365584

BETA ALPHA R

FORWARD Y SN 114 100

FIGURE 93

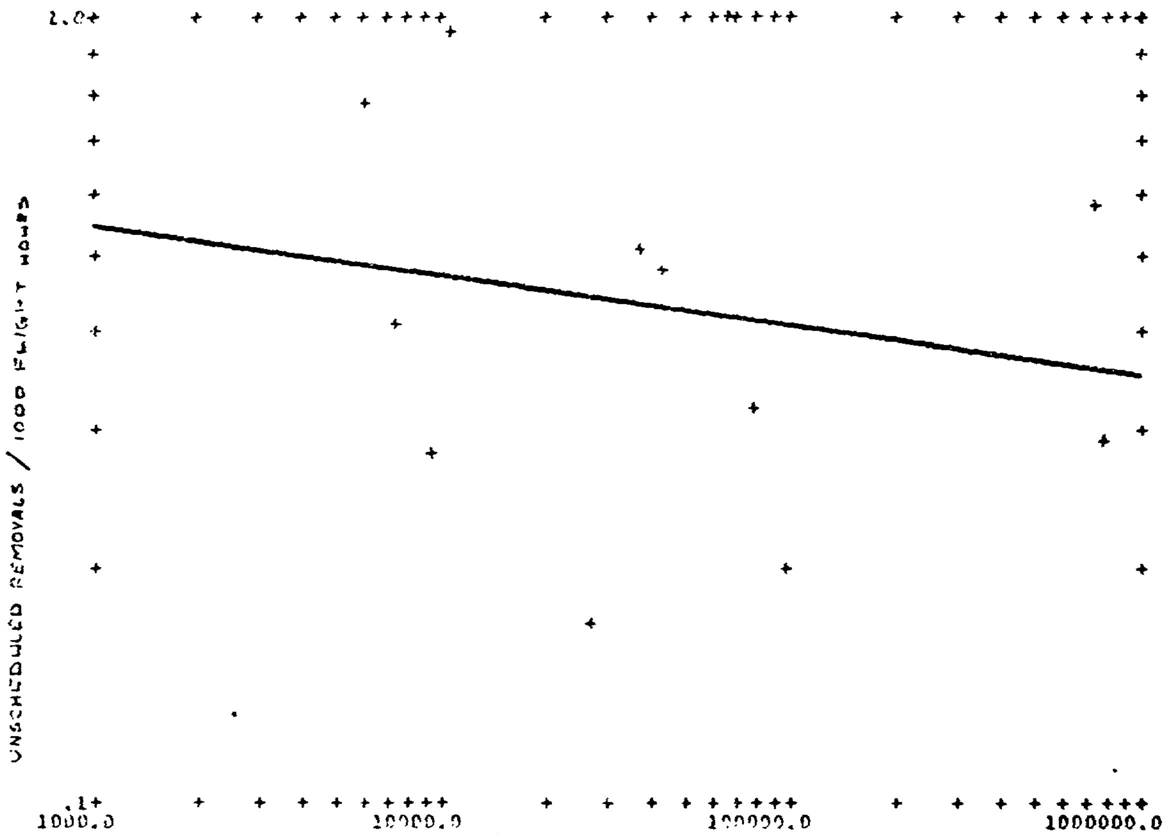


-.158219 -.040051 10.604935 -.59415 1.559531 .220200 -.278640

BETA ALPHA R

AFT ASSY 114P7001

FIGURE 94



-.168468 -.063295 10.694835 -.845329 1.559531 .559194 -.176523

BETA ALPHA R

AFT NSN 11402301

FIGURE 95

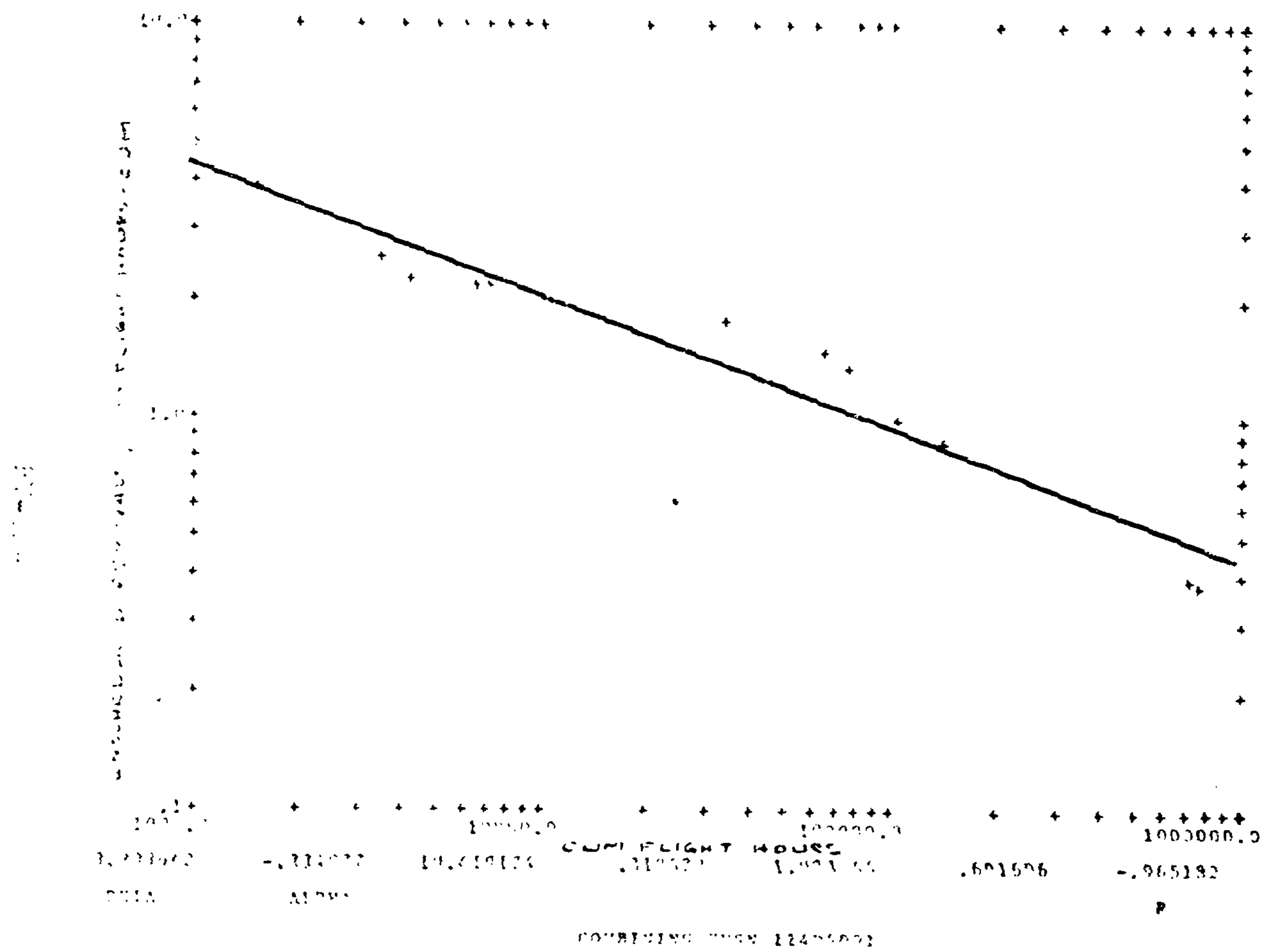
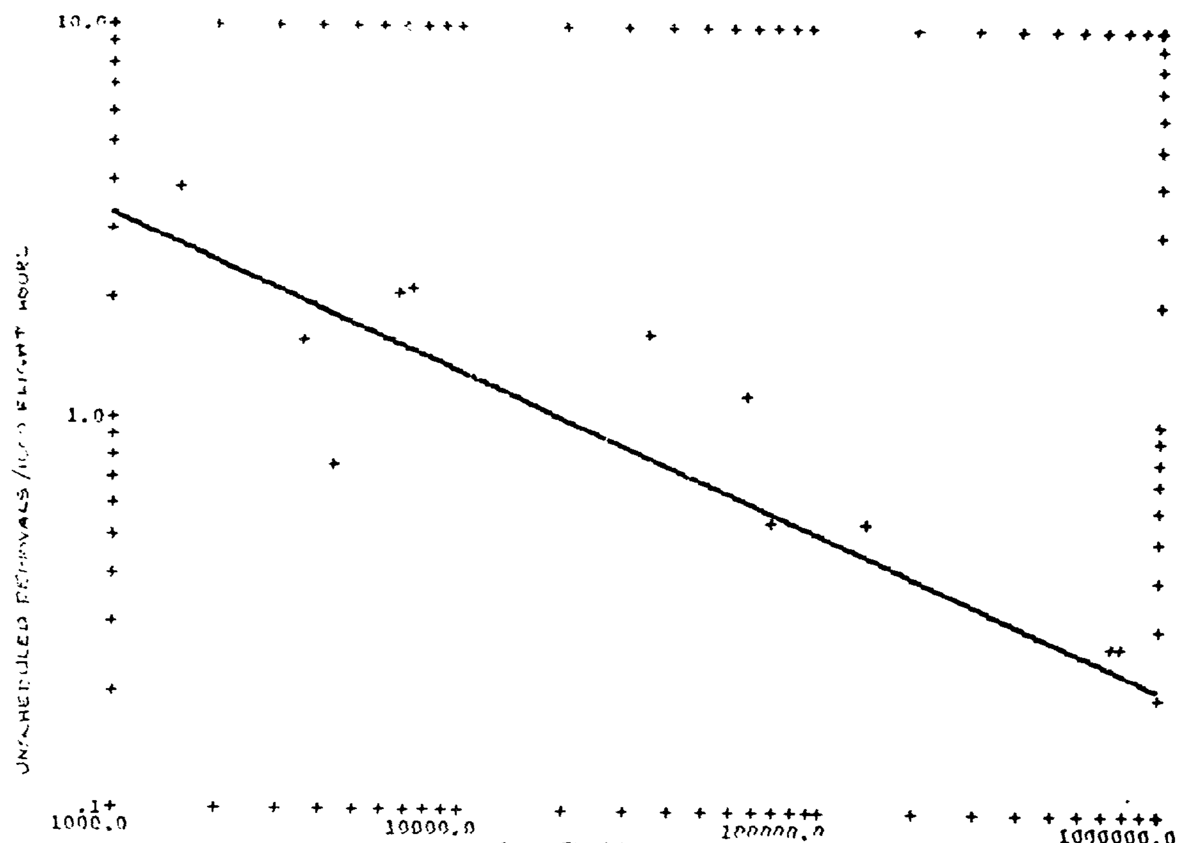


FIGURE 96

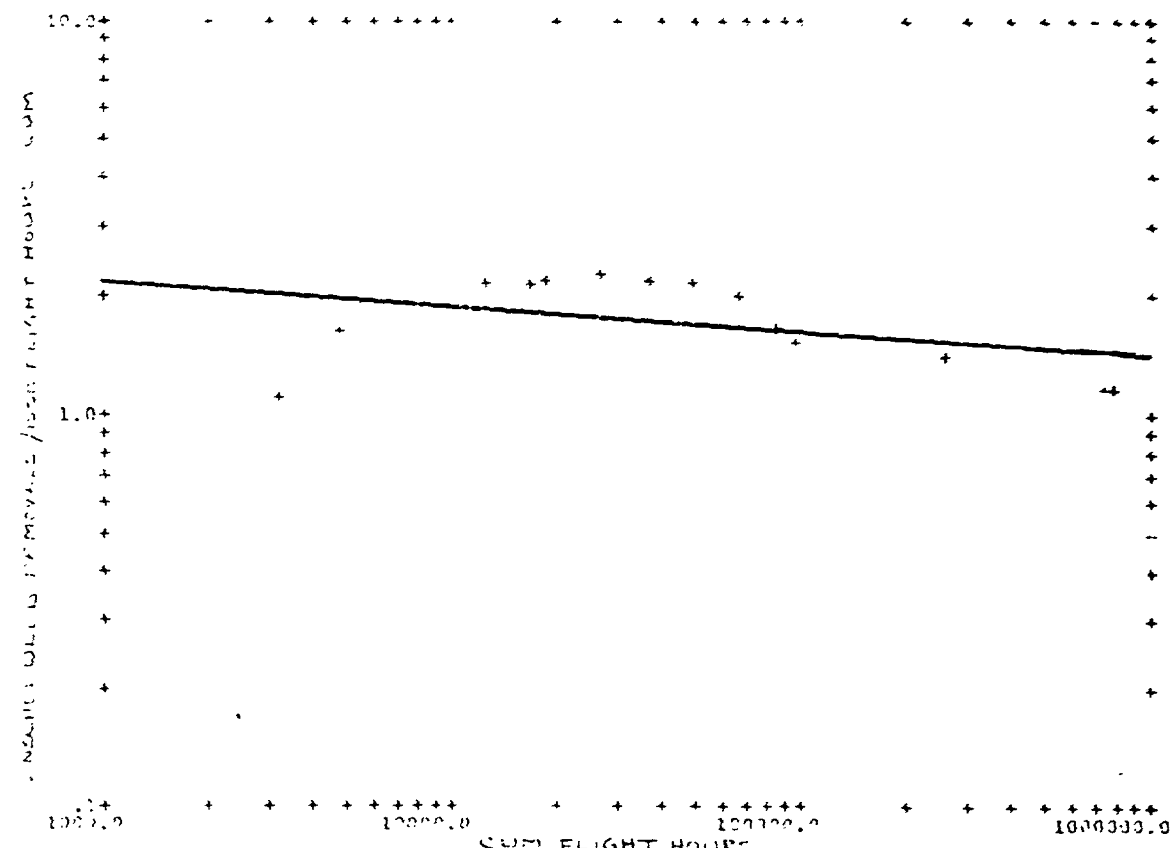


3.965339 -.400158 10.419124 -.203957 1.993244 1.012137 -.783?37

BETA ALPHA r

COMBINING XMSN 114D5901

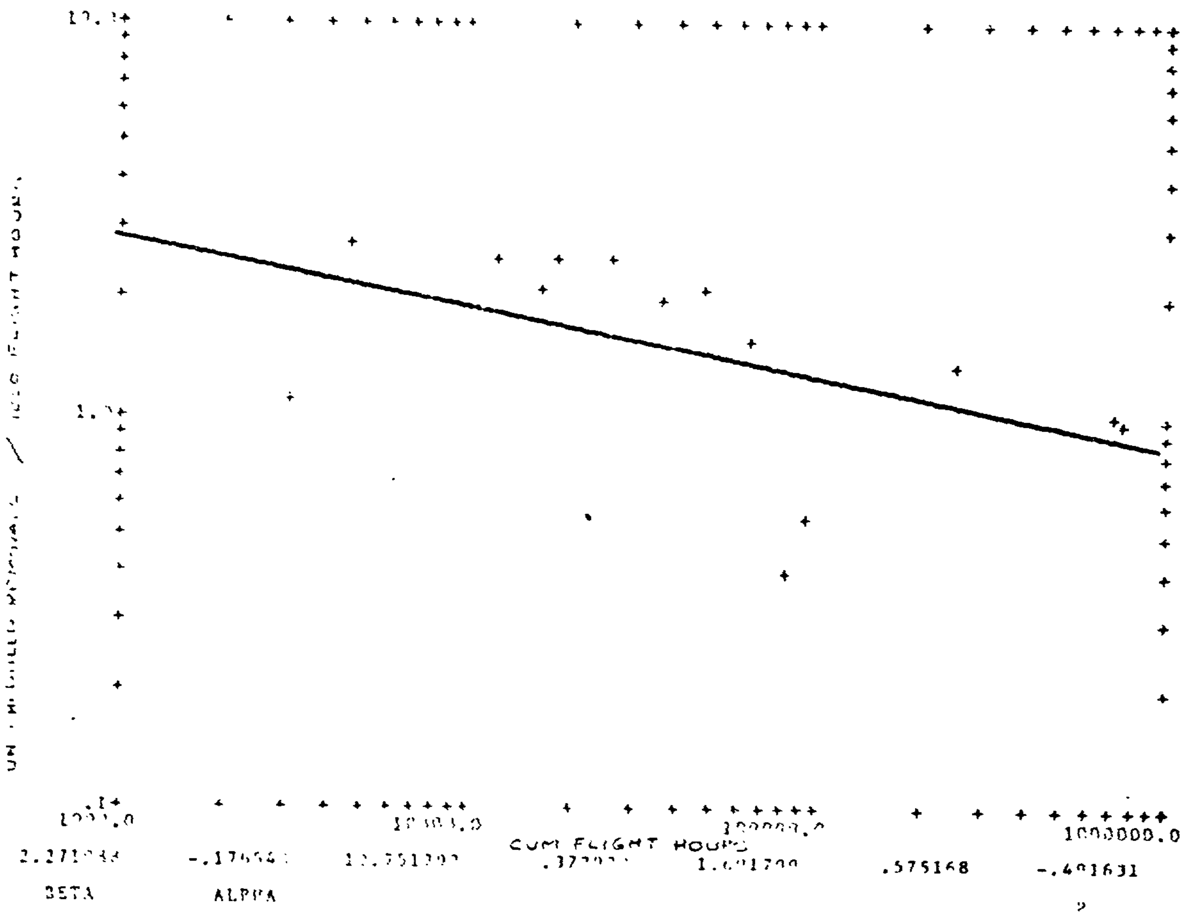
FIGURE 97



1.216116	-.062924	10.731792	.53	1.601700	.260546	-.336828
BETA	ALPHA					R

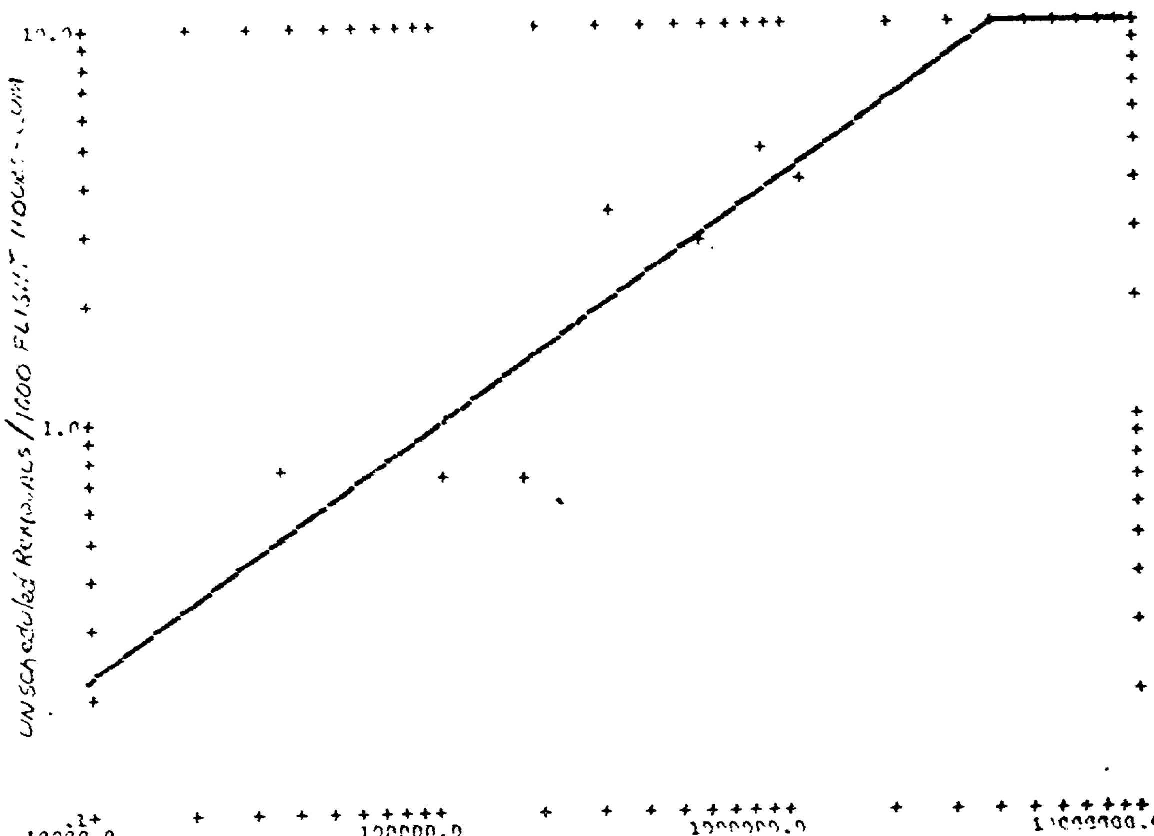
ENGINE S SN 114 6001

FIGURE 96



EN INV NSN 11490001

FIGURE 99

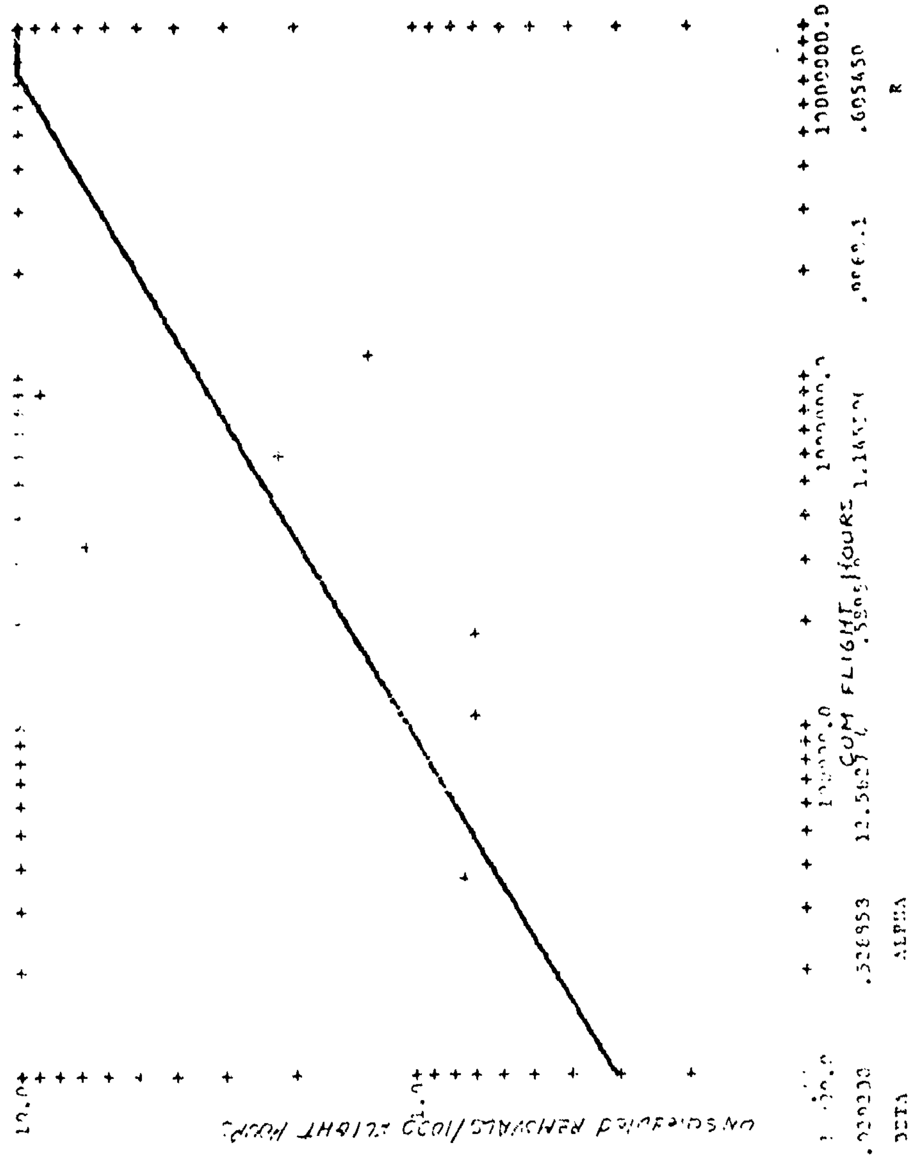


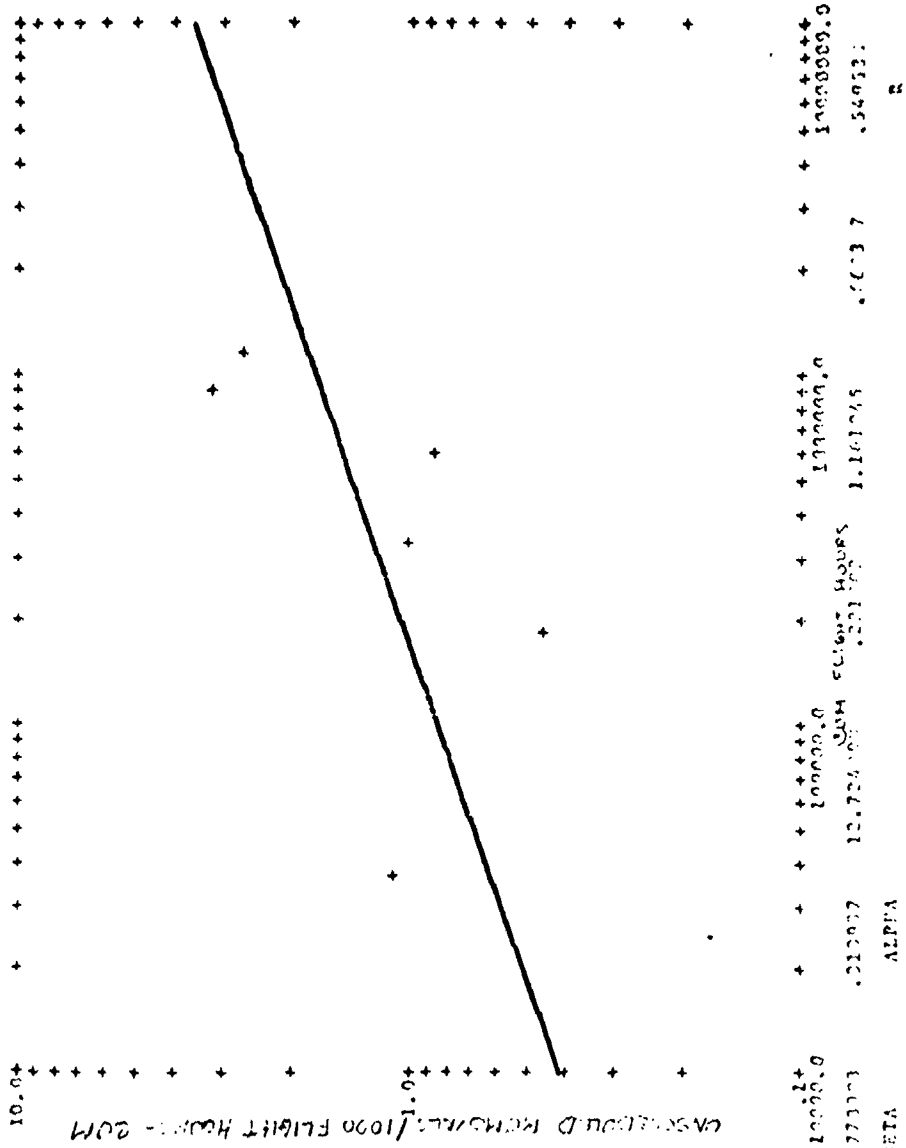
-7.327666 .632035 12.5627 4 .617432 1.14550 .321077 .8 1769

BETA ALPHA R

N2 ALTA 0?

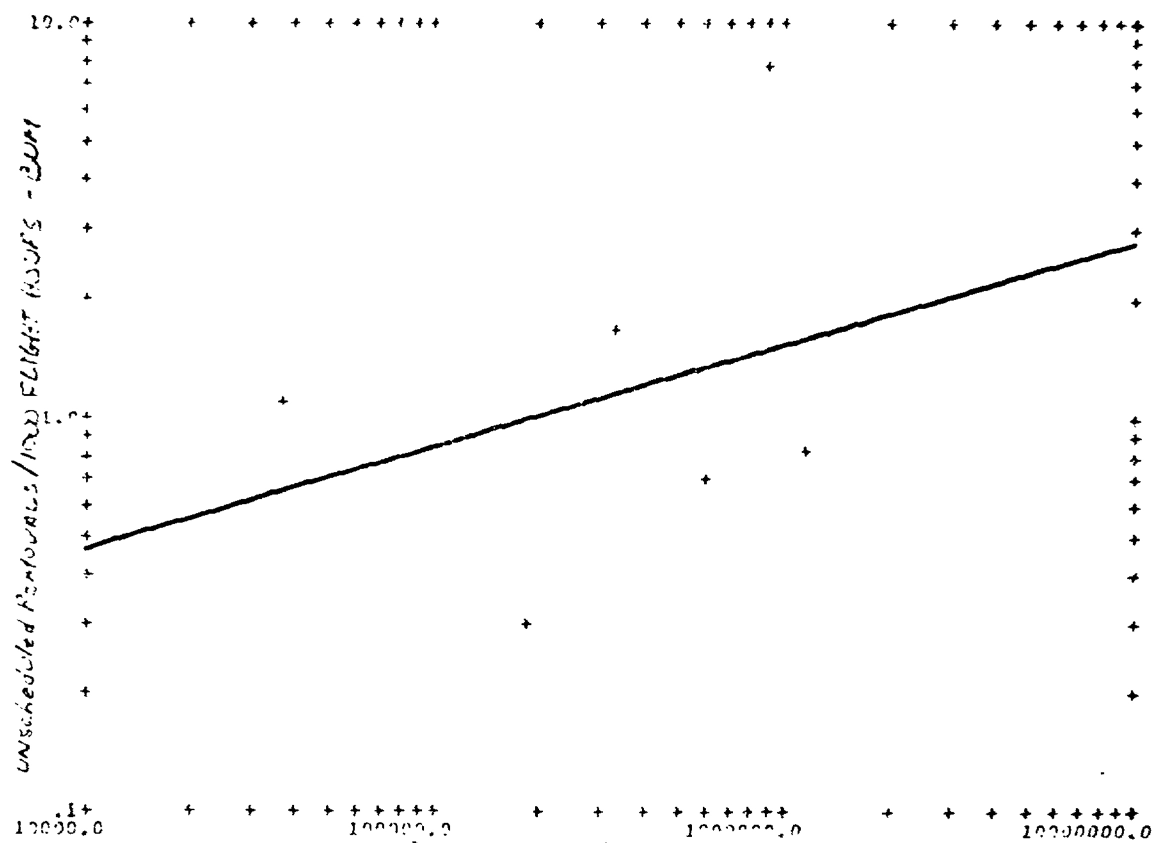
FIGURE 100


CUM FLIGHT HOURS
ALPHA
R
.605450
1000000.0



A.T.ATO

FIGURE 107

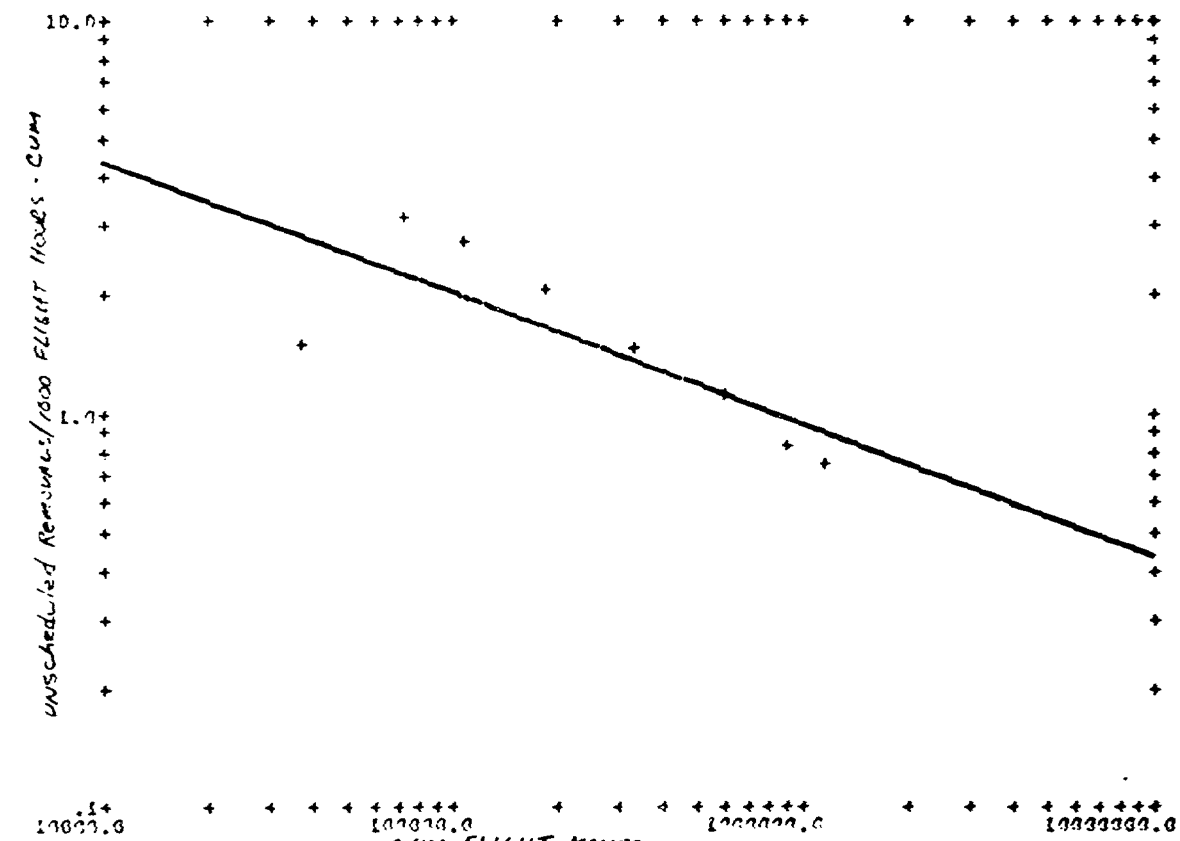


-3.15568 .260087 12.776 .1330 1.113965 .995132 .302542

BETA ALPHA R

STATOR

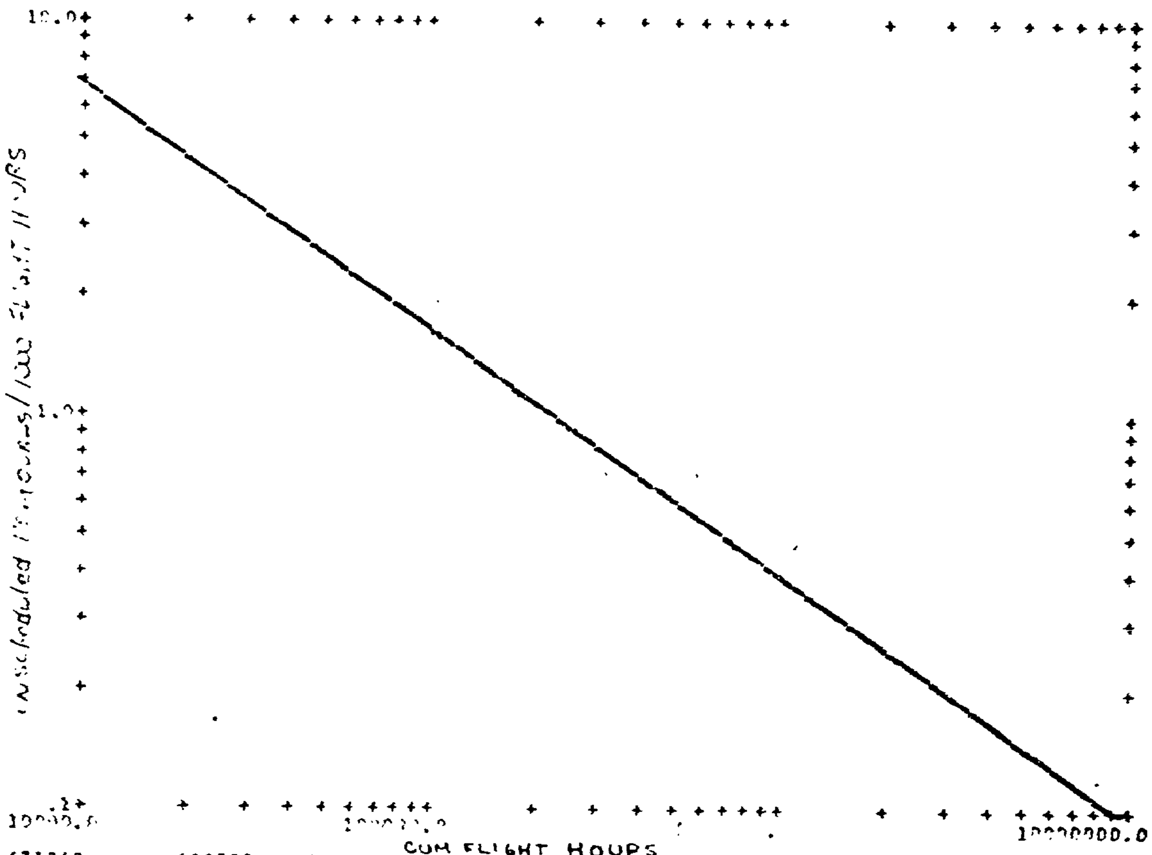
FIGURE 103



4.53627	-.334237	12.?91665	.416512	1.163232	.49?347	-.88077
BETA	ALPHA					R

PIVOTING ACTUATOR

FIGURE 104

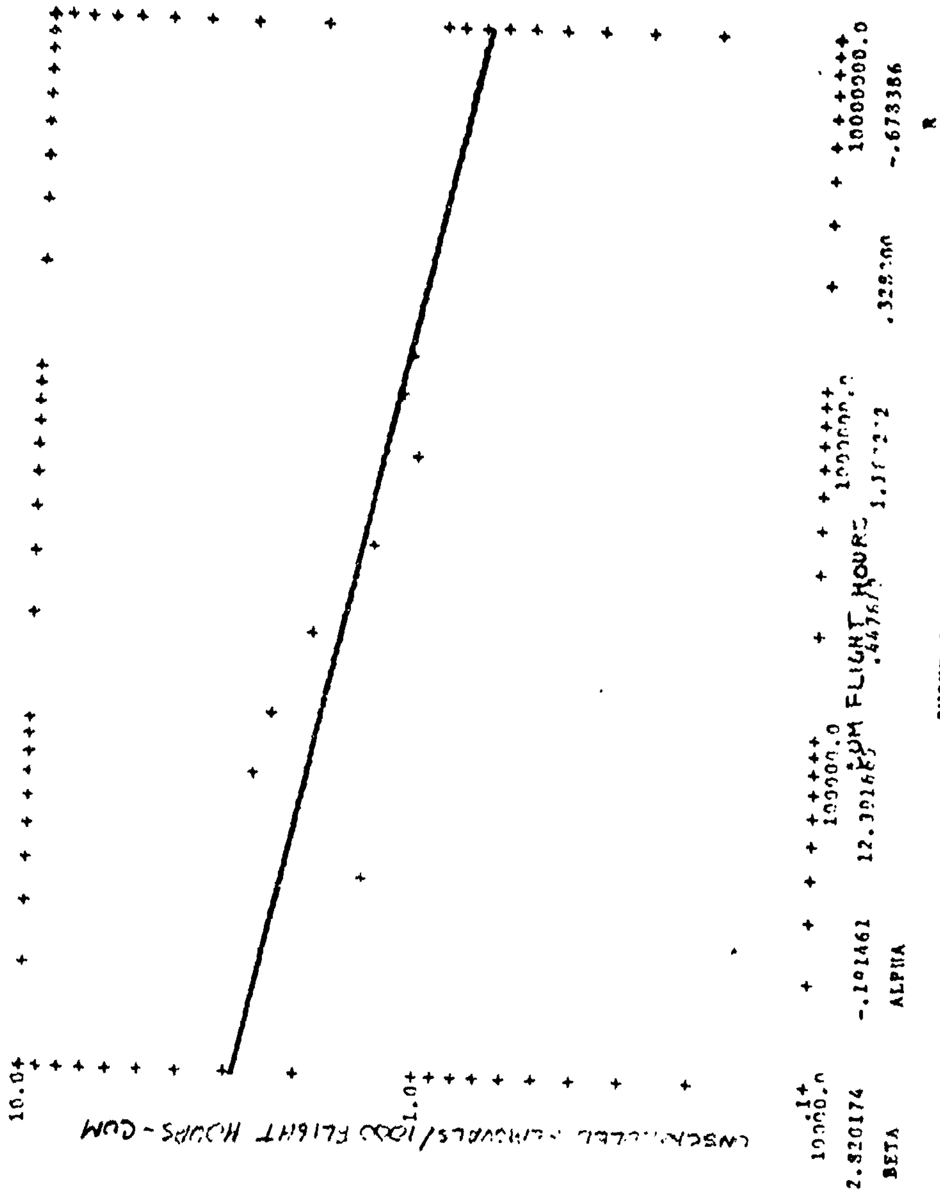


7.671343 -.629723 12.321665 -.02045 1.103332 .067730 -.35913

BETA ALPHA R

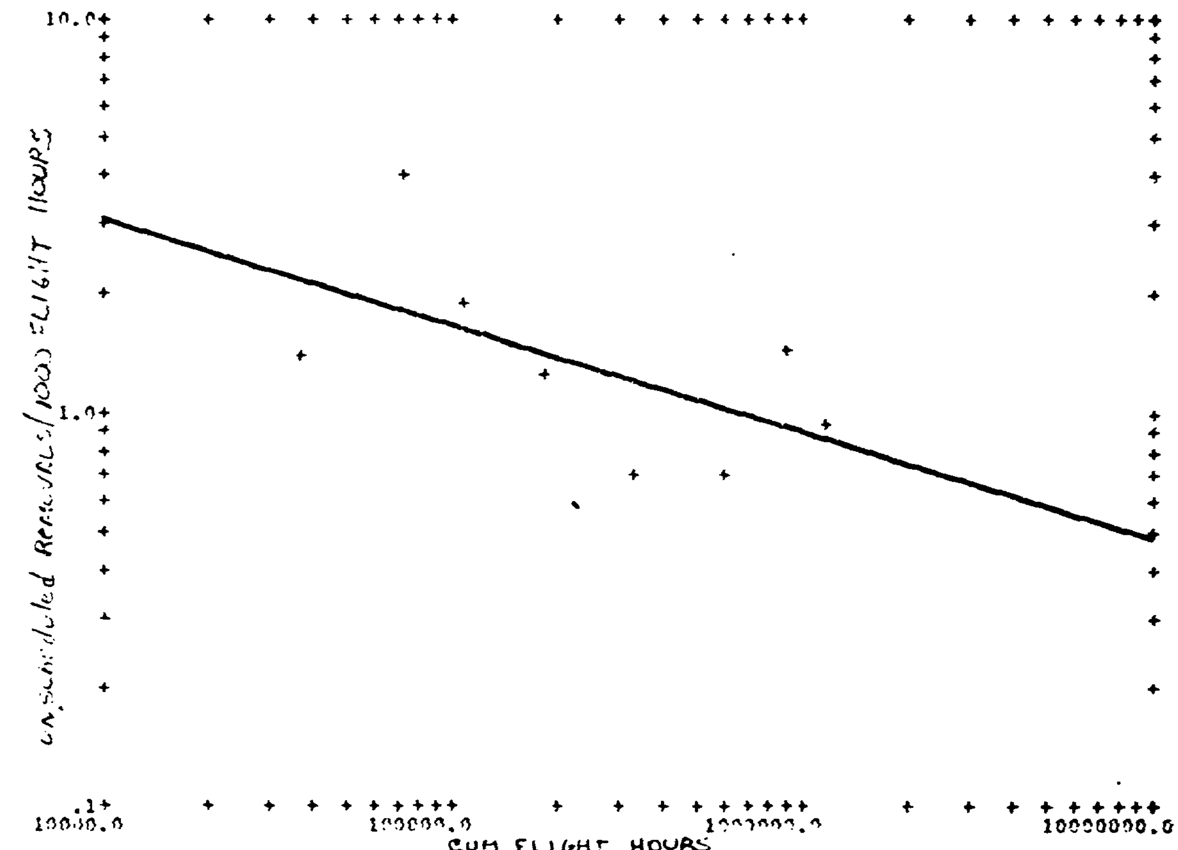
PIVOTING ACTUATOR

FIGURE 105



SHIVE ING ACTUATOR

FIGURE 106

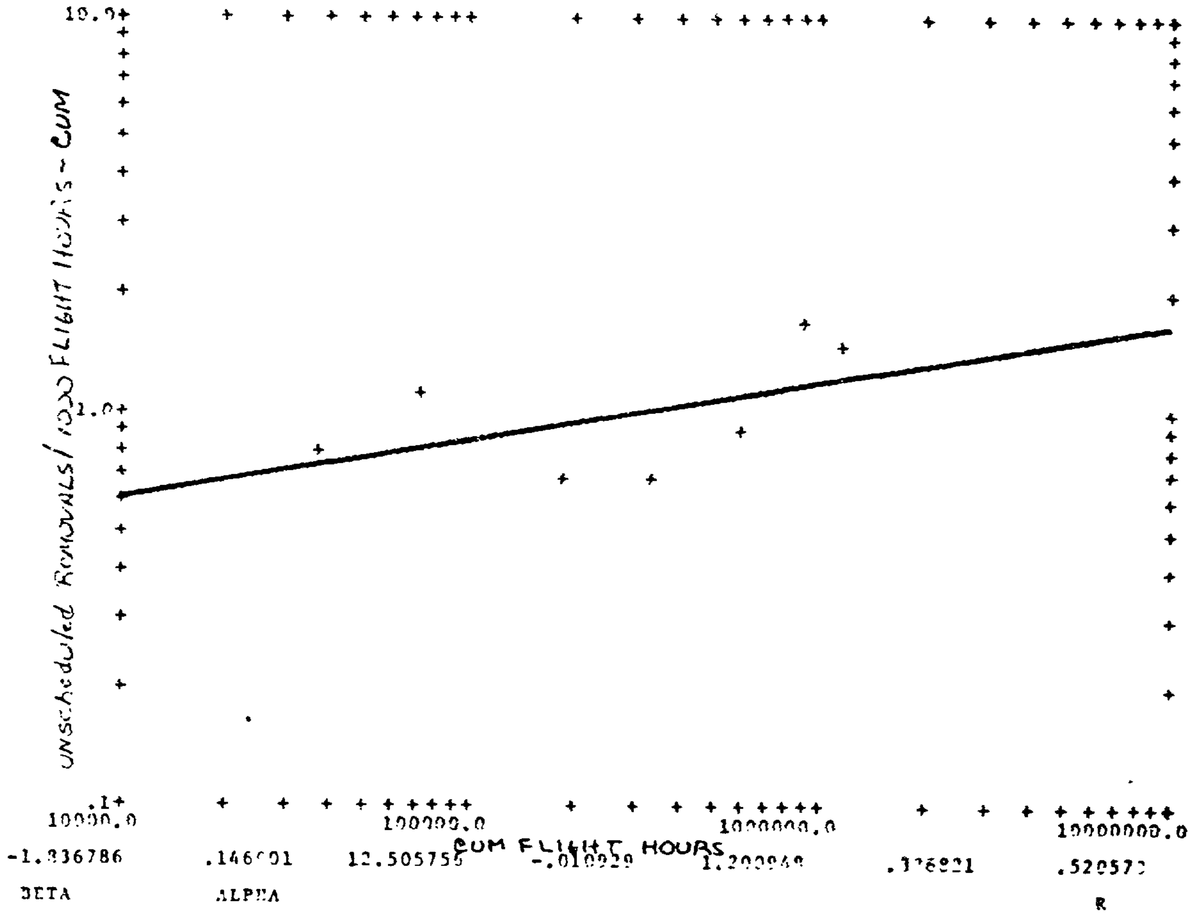


3.605963 -.268967 17.391665 .271013 [illegible] [illegible] -.583910

BETA ALPHA R

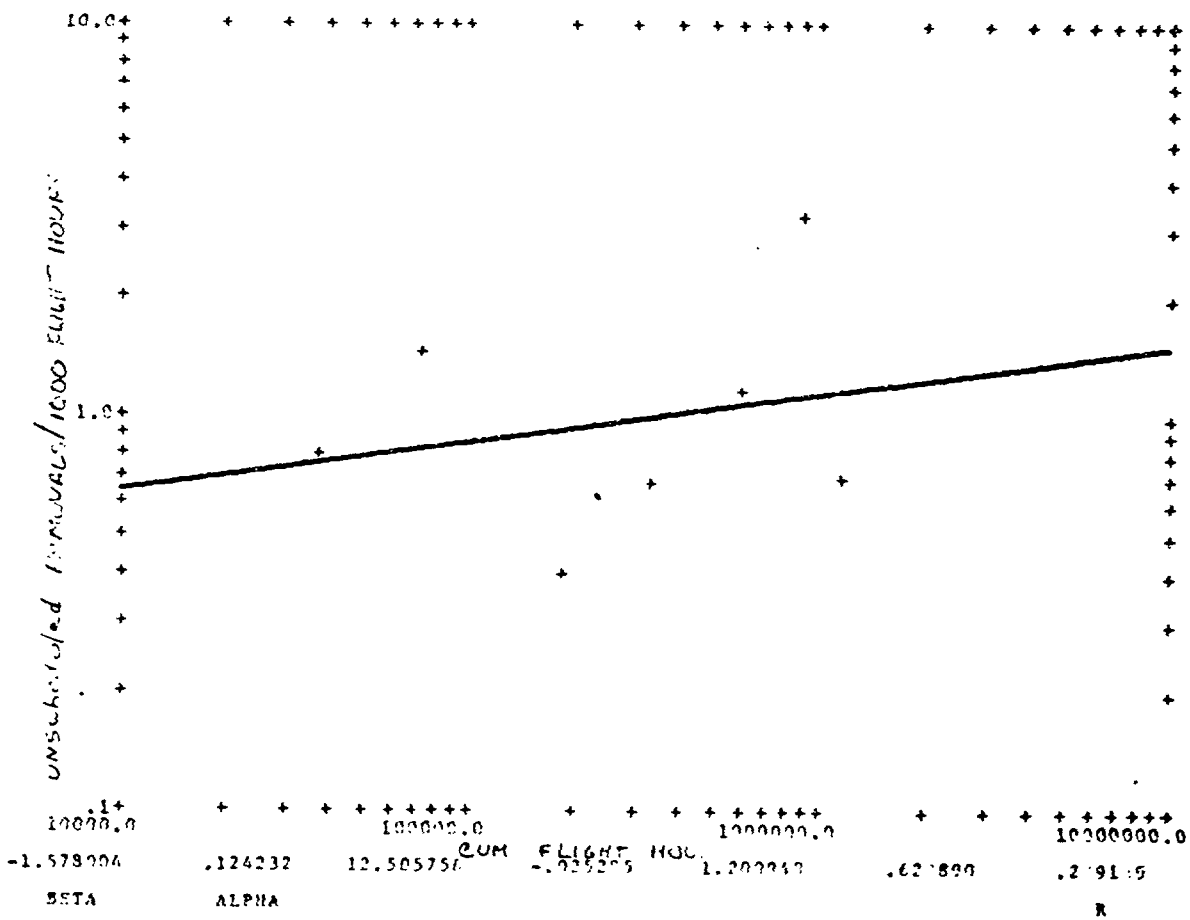
SHIVE ING ACTUATOR

FIGURE 107



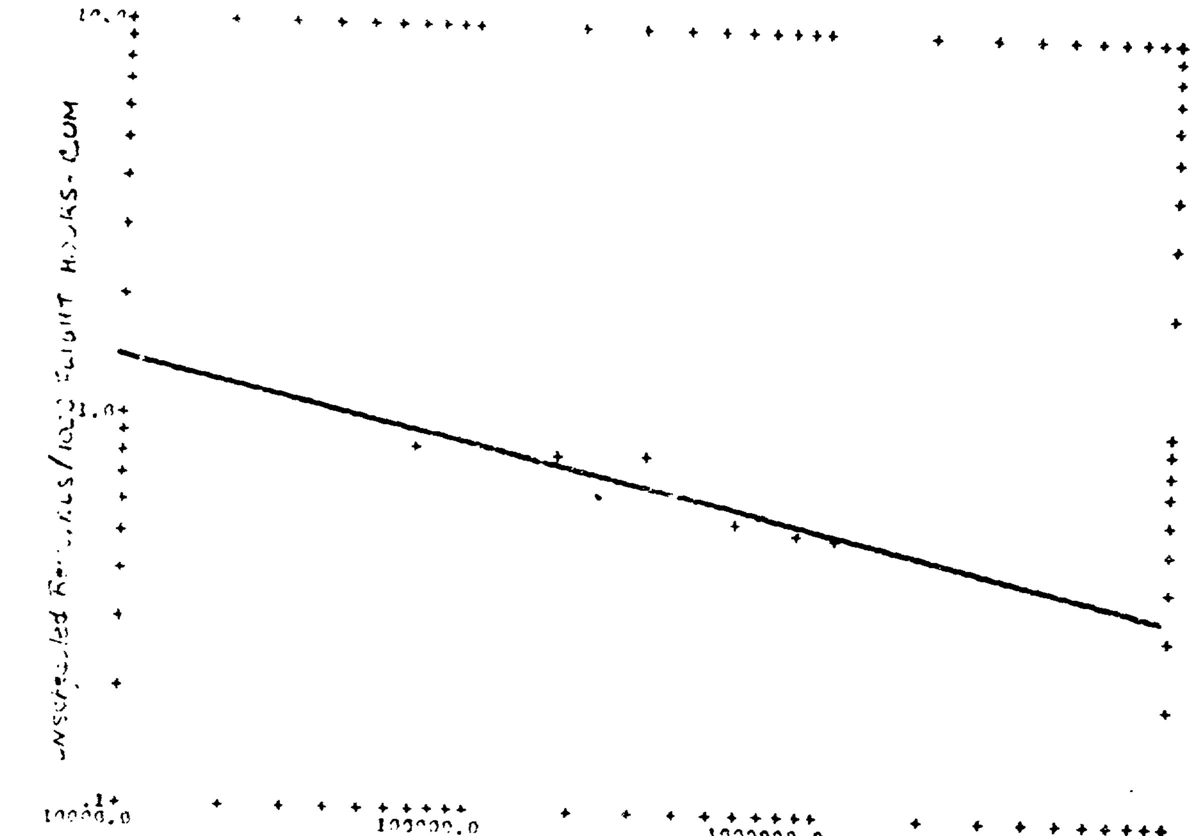
ROTOR BLADES

FIGURE 108



ROTOR BLADES

FIGURE K19

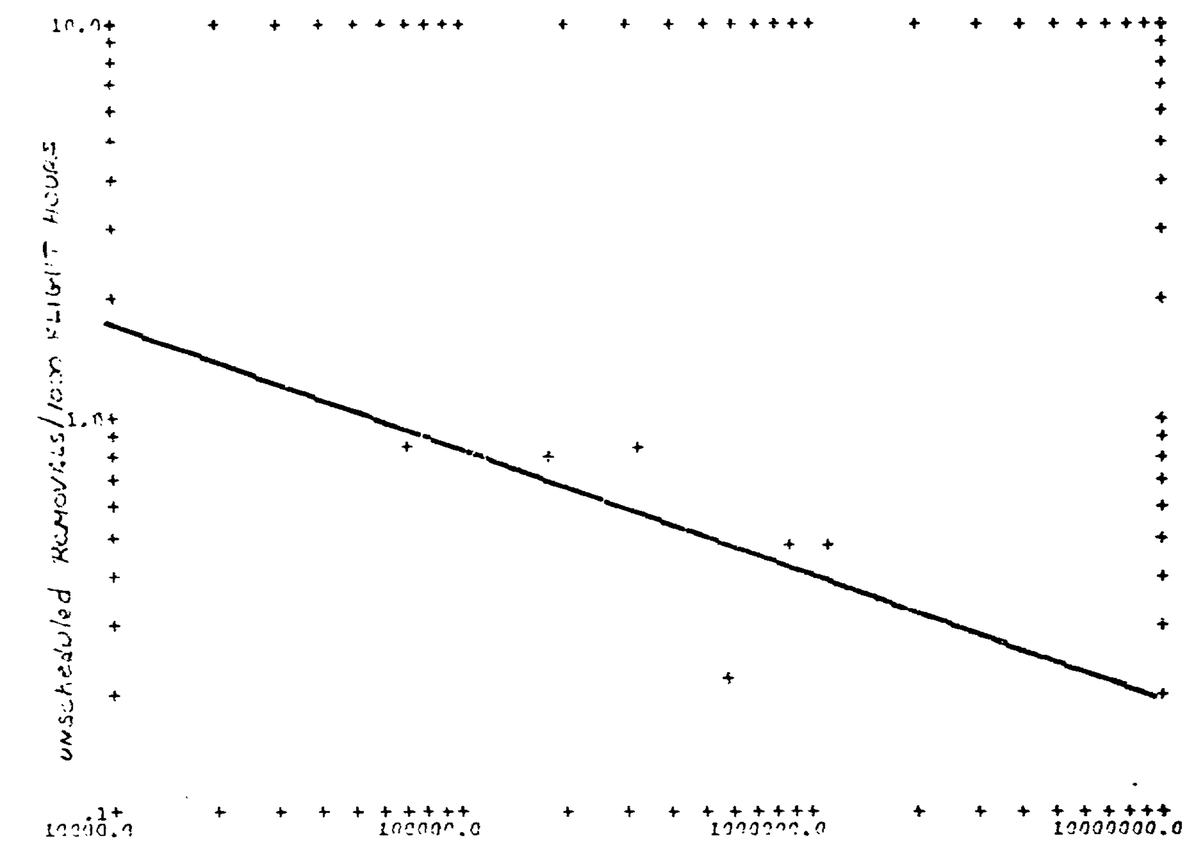


2.750259 -.207132 17.816787 -.40265 .95[illegible] .221590 -.896429

BETA ALPHA R

SWASHPLATES

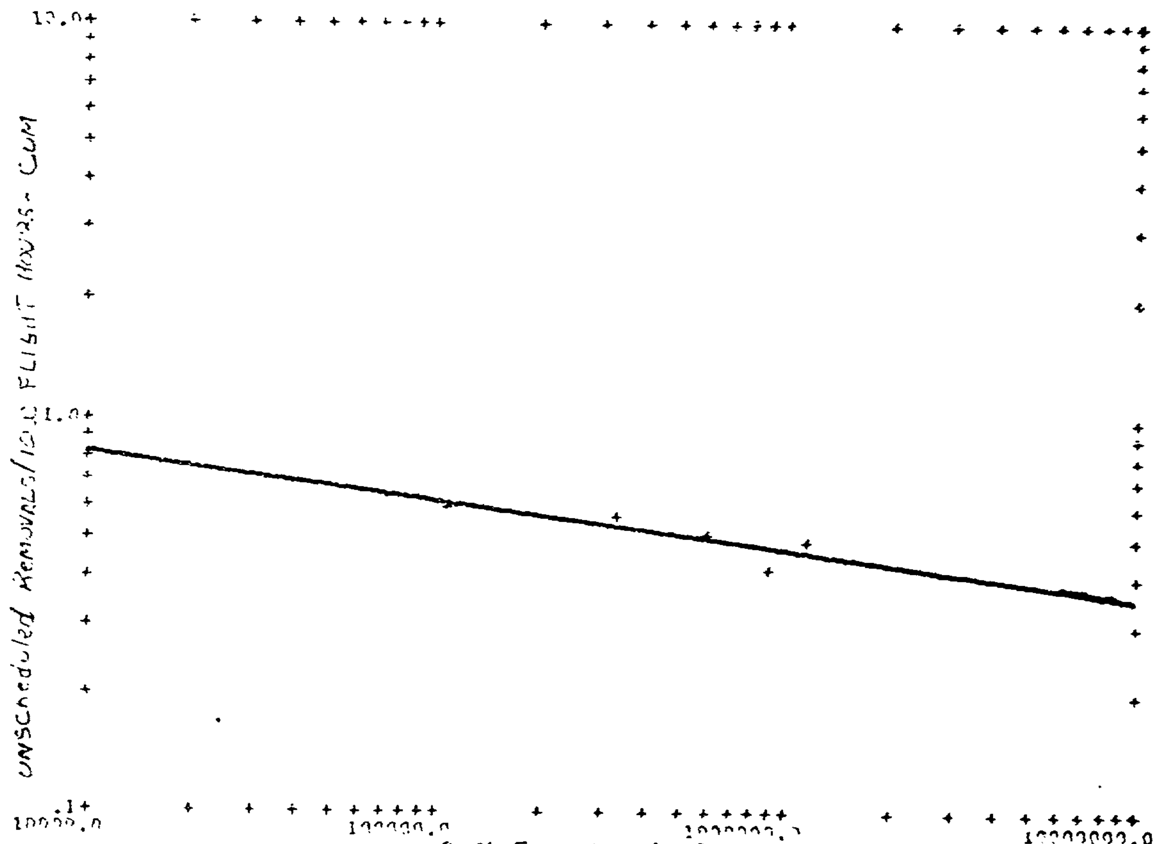
FIGURE 110



3.473455 -.316574 12.8?6787 -.5??346 .956960 .420546 -.630360

BETA ALPHA R

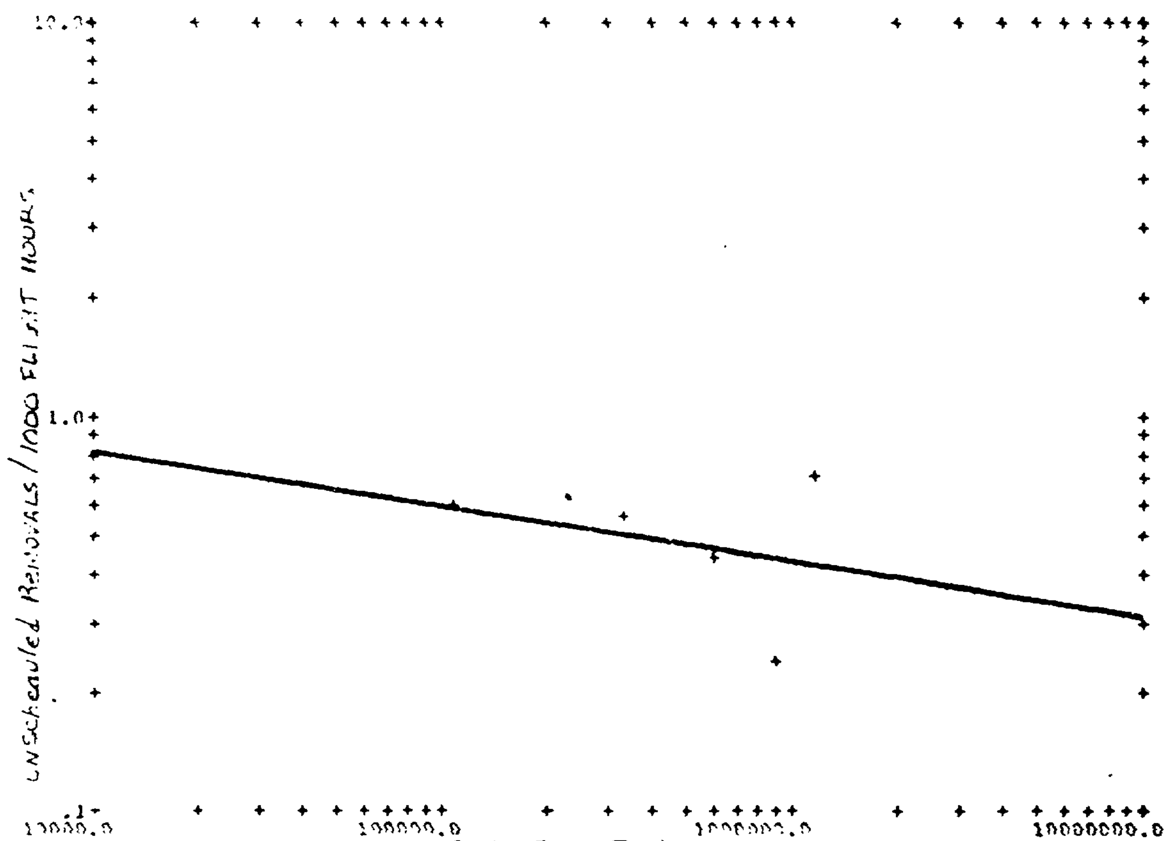
SWASHPLATES
FIGURE III



.1 7752 -.122769 11.0594 2 -.665427 .866500 .124 1 -.833332

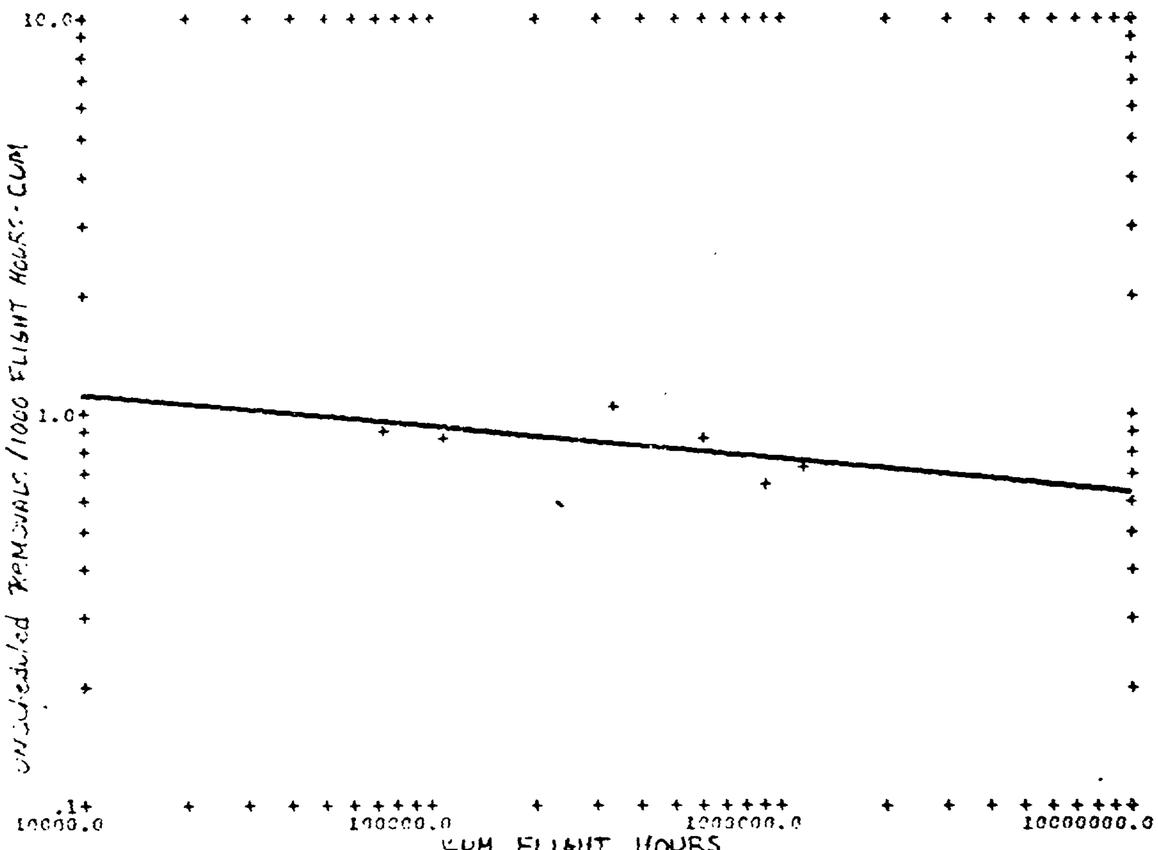
BETA ALPHA R

HYDRAULIC PUMP
FIGURE 82



1.03·056	-.1·9378	1·.0594 2	-.733256	.846500	.78102	-.312074
BETA	ALPHA					R

HYDRAULIC PUMP
FIGURE 113

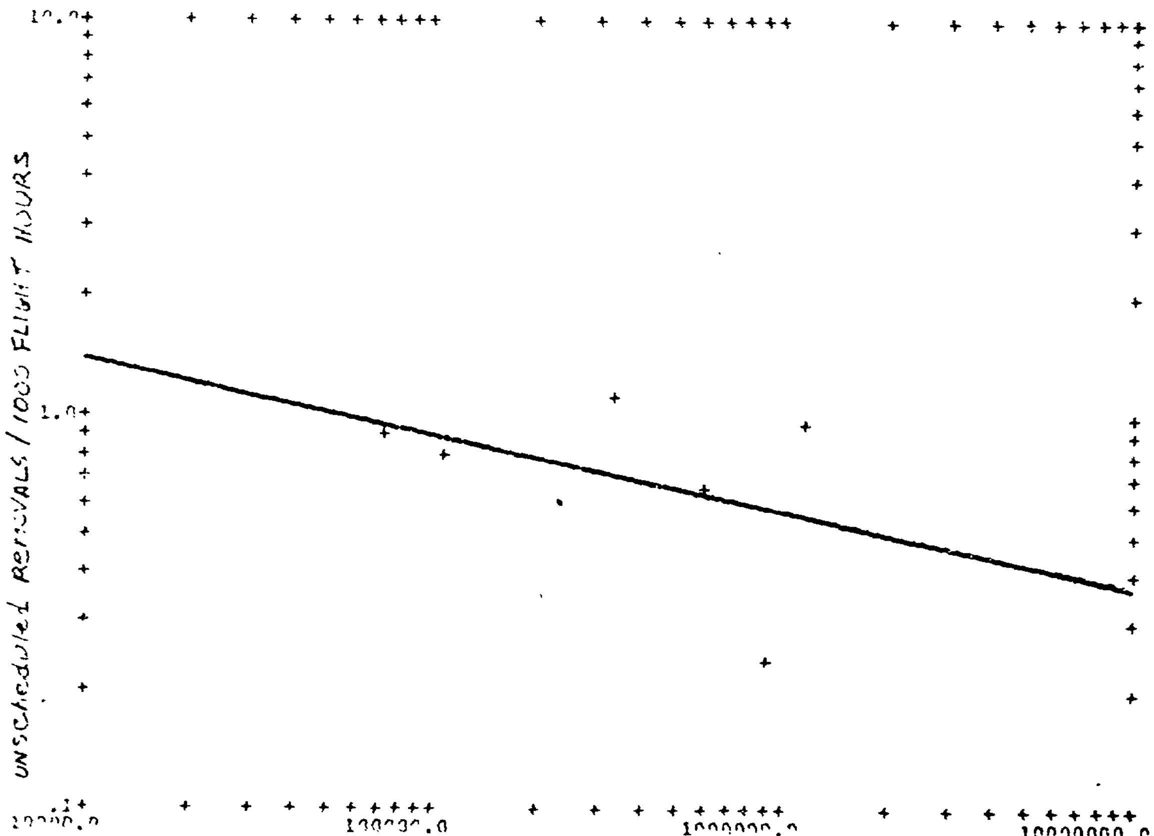


.939950 -.033154 12.749511 -.17... 1...0530 .147511 -.586000

BETA ALPHA

CYCLIC TRIM ACTUATOR

FIGURE 114



2.000710 -.101433 12.742511 -.348771 1.000530 .508176 -.381444

BETA ALPHA R

CYCLIC TRIM ACTUATOR

FIGURE 115

TABLE 10 - CH-47 XMSN R GROWTH PARAMETERS

TRANSMISSION	UNS. REM. /1,000 FH-CUM			UNS. REM. /1,000 FH		
	B	α	R	B.	α	R.
FORWARD XMSN	5.293	-.450	-.786	4.870	-.446	-.766
AFT XMSN	-.158	-.041	-.279	-.168	-.064	-.177
COMBINING XMSN	3.809	-.335	-.965	3.965	-.400	-.783
ENGINE XMSN	1.216	-.063	-.387	2.271	-.177	-.492

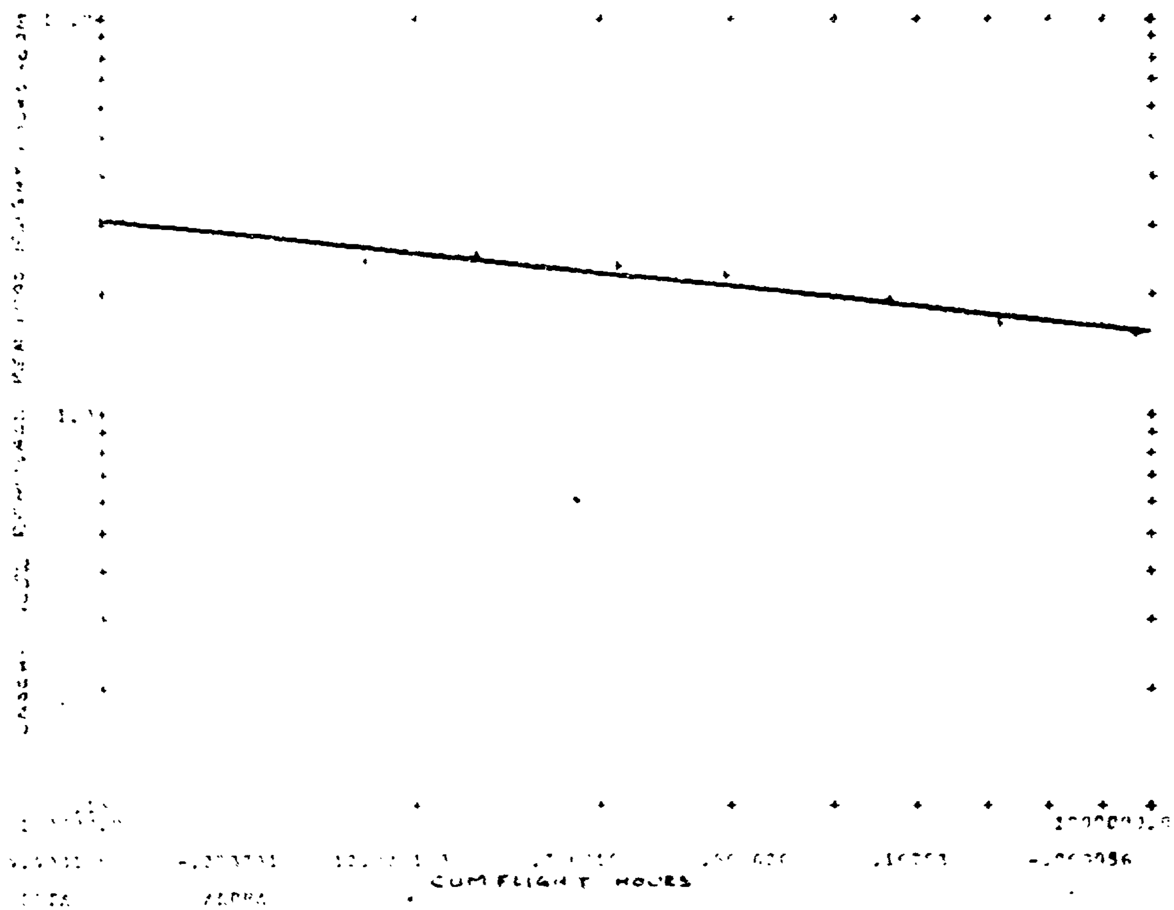
TA[illegible] II - [illegible] R GROWTH PARAMETERS

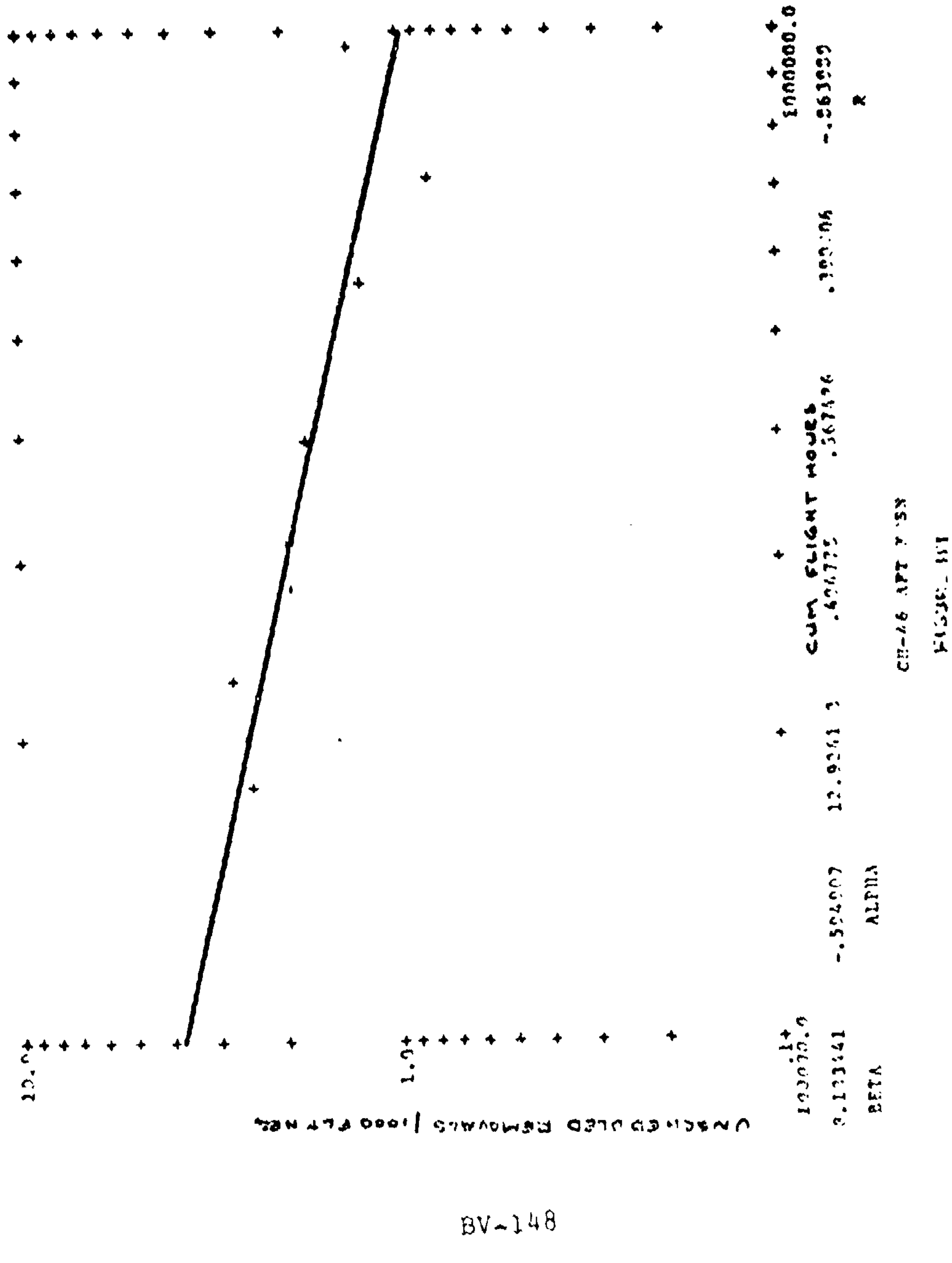
COMPONENT	UNS. REM./1,000 FH-CUM			UNS. REM./1,000 FH		
	L	[illegible]	[illegible]	B	[illegible]	[illegible]
N[illegible] ACTUATOR	-7.328	.32	.552	-6.029	.527	.605
NI ACTUATOR	-3.7[illegible]	.314	.550	-2.155	.250	.303
PIVOTING ACTUATOR	4.55[illegible]	.334	-.755	7.[illegible]	-.621	-.536
SWIVELING ACTUATOR	2.820	-.191	-.678	3.6[illegible]	-.269	-.584
ROTOR BLADES	-1.837	.14[illegible]	.521	-1.579	.124	.239
SWASHPLATES	0.256	-.207	-.894	2.4[illegible]	-.217	-.630
HYDRAULIC PUMP	.938	-.12[illegible]	-.833	1.04[illegible]	.139	-.312
CYCLIC TRIM ACT.	.881	-.083	-.586	2.[illegible]1	-.191	-.391

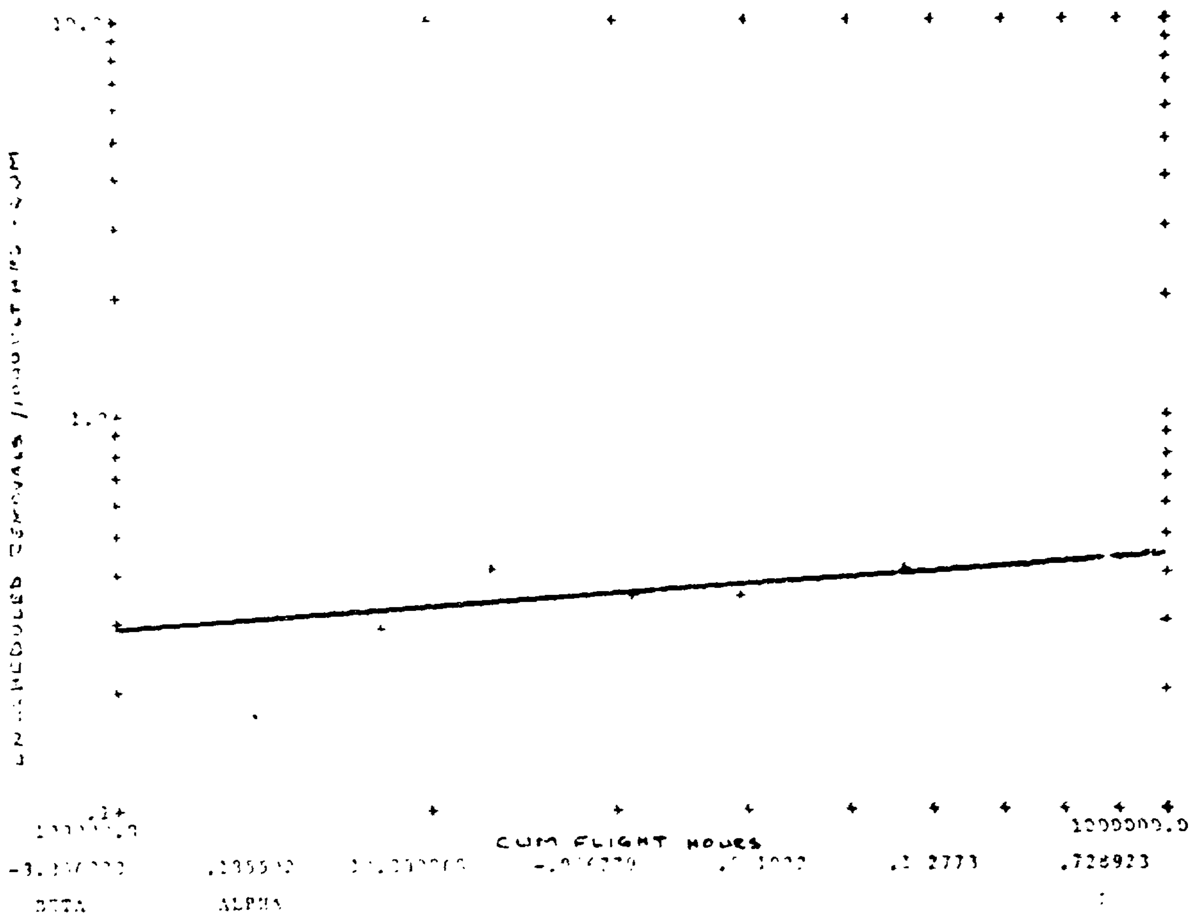
TABLE 12 - CH-46 COMPONENT K GROWTH STATISTICS

[illegible]	COMPONENT YEAR	AFT [illegible]		[illegible]		ROTOR HEAD A		ROTOR HEAD D		ROTOR HEAD A[illegible]	
179020	[illegible]	2.445	2.445	.290	.290	1.412	1.412	.408	.408	1.365	1.365
225[illegible]	[illegible]	2.762	2.513	.860	.413	1.618	1.456	1.328	.606	1.267	1.344
311085	[illegible]	1.980	2.371	.165	.352	1.782	[illegible]	1.252	.778	.968	1.244
344129	END 1968	1.748	2.240	.339	[illegible]	1.705	1.619	1.488	.124	.610	1.110
563306	END 1969	1.245	1.941	.546	.408			1.887	1.216	1.249	1.152
717637	END 1970	.820	1.700								
964000	END 1972	1.338	1.661	.502	.447			1.625	1.308	1.195	1.170

*** - BOEING IOM 8-7975-3B-323 [illegible]
BOEING VERTOL PROCESSED 3M DATA ***

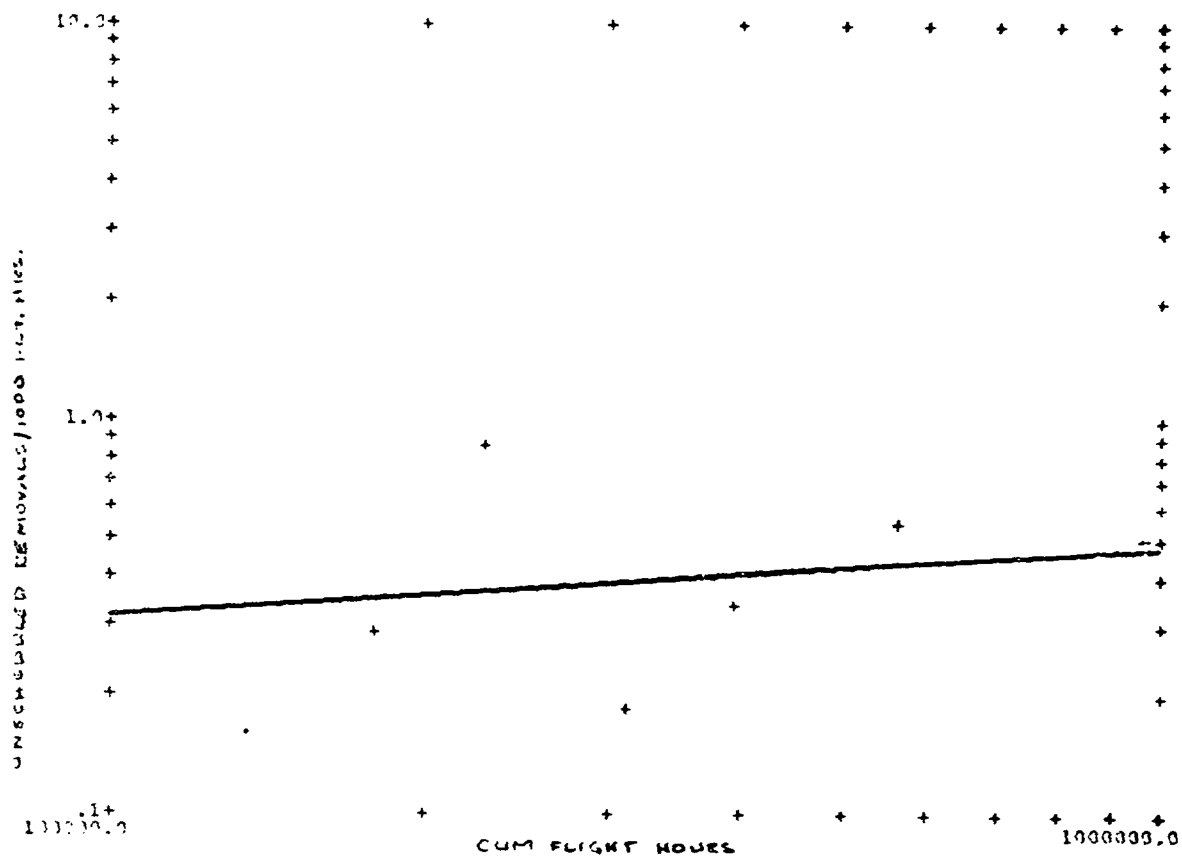

CUM FLIGHT HOURS


10.0
1.0
1000000.0
CUM. FLIGHT HOURS
ALPHA
BETA



CH-46 Forward [illegible]

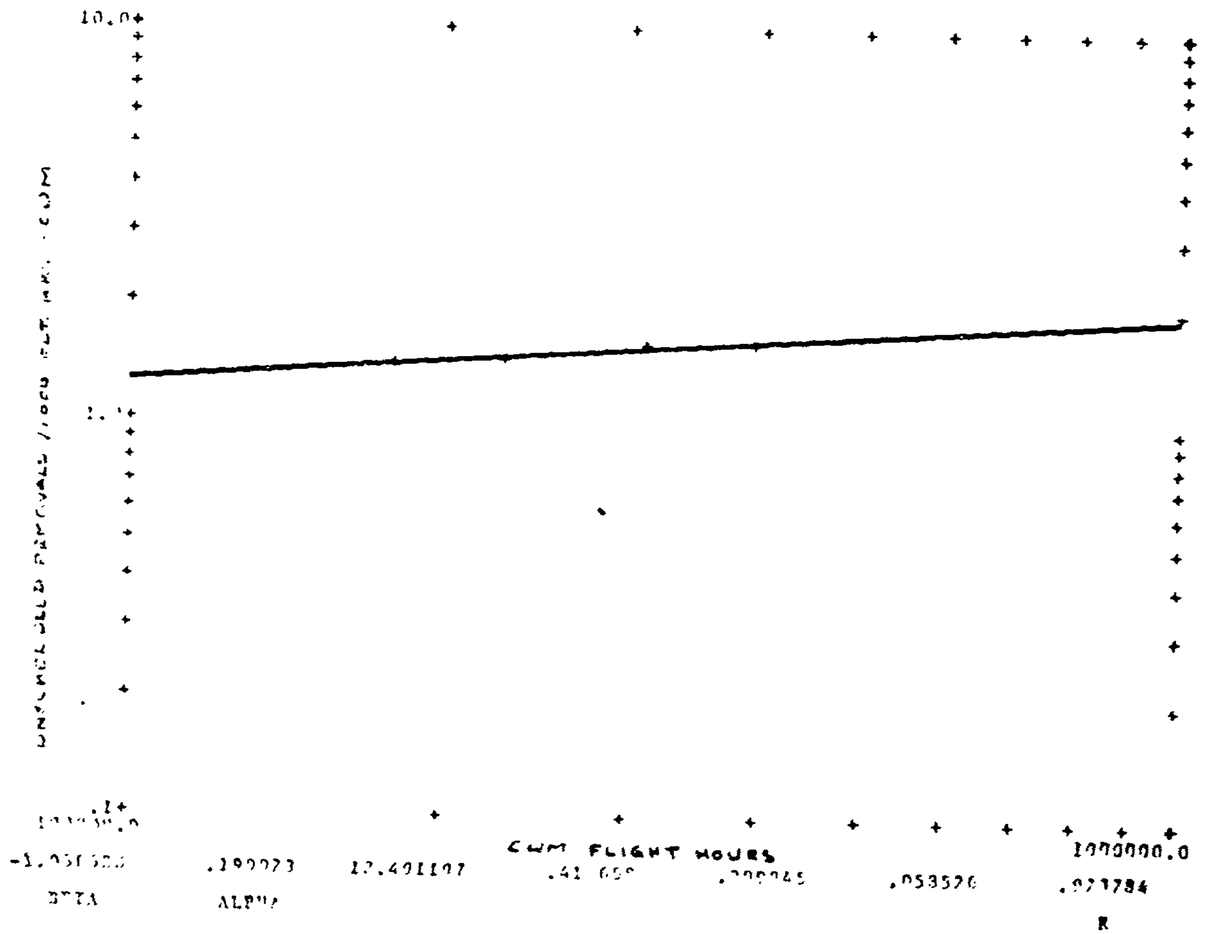
FIGURE 118



-1.178[illegible]	.176933	[illegible]	-.[illegible]	.561[illegible]	.[illegible]	.291270
BETA	ALPHA					R

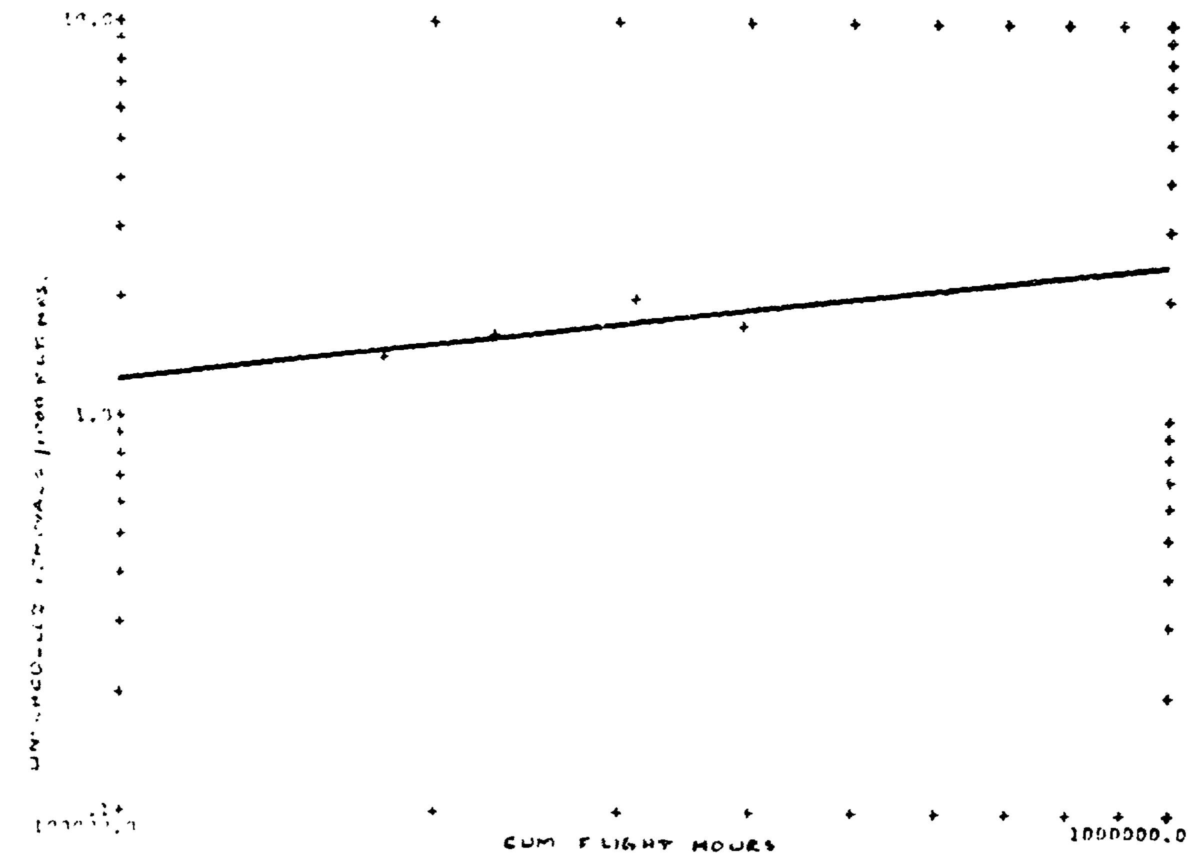
CH-46 FORWARD [illegible]

FIGURE 119



CH-46 ... HEA. 'A'

FIGURE 120

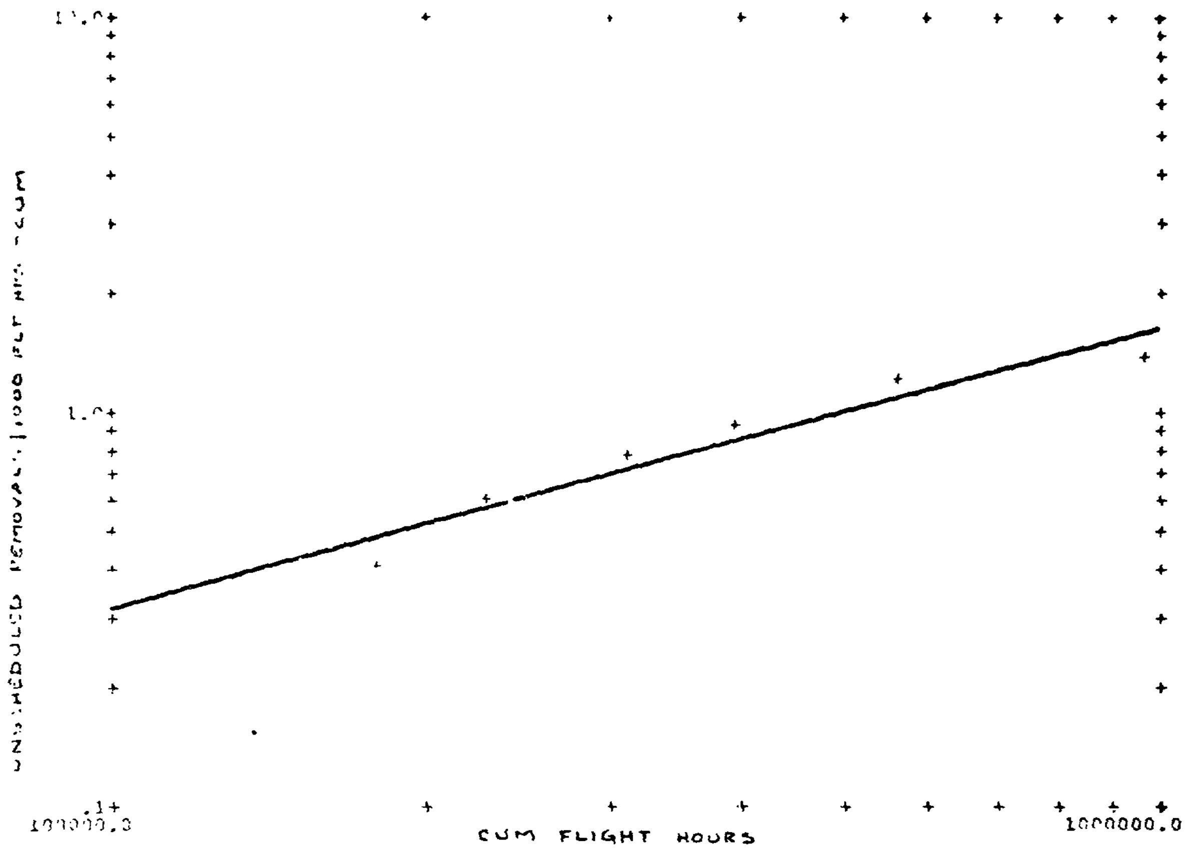


[illegible]

BETA ALPHA

H-46 FWD. ROTOR HEAD 'A'

FIGURE (2)

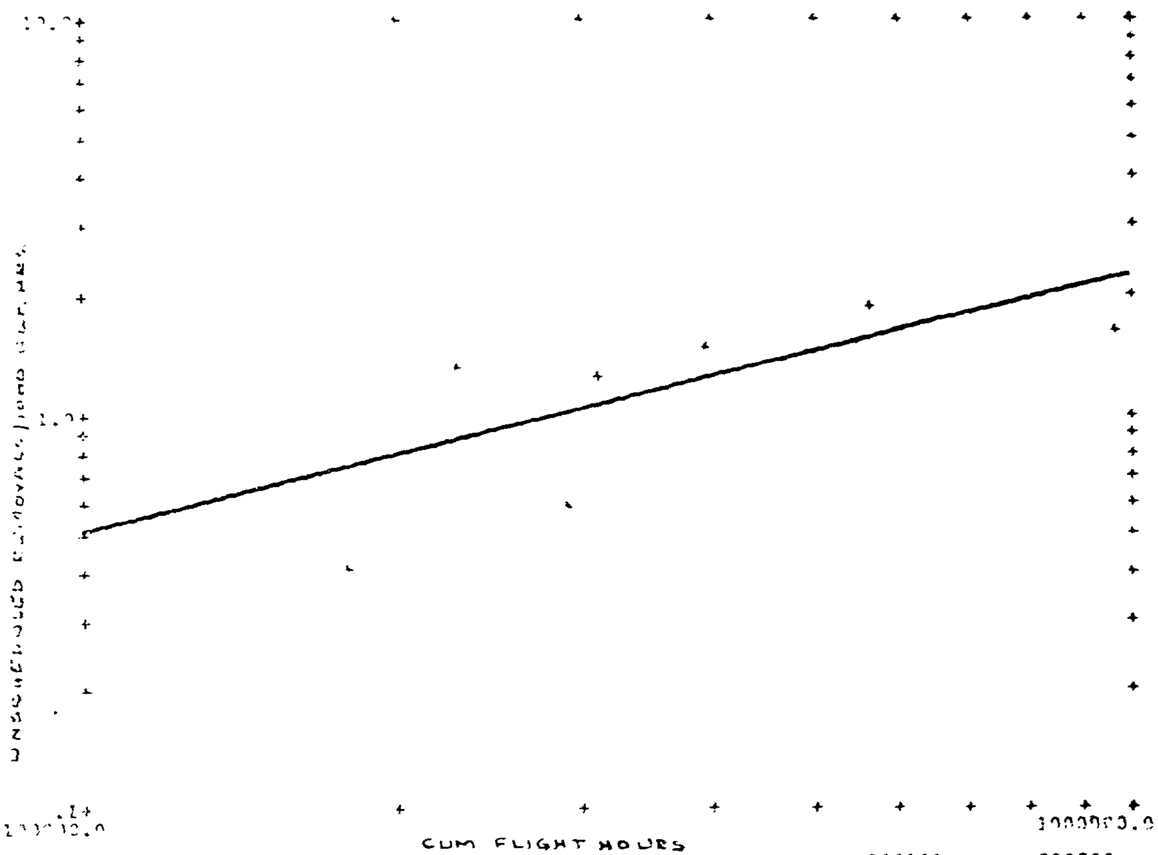


-0.293793 .793721 12.930868 -.2001[illegible] .561922 .413326 .960811

BETA ALPHA R

CH-46 FWD. ROTOR HEAD 'D'

FIGURE 122

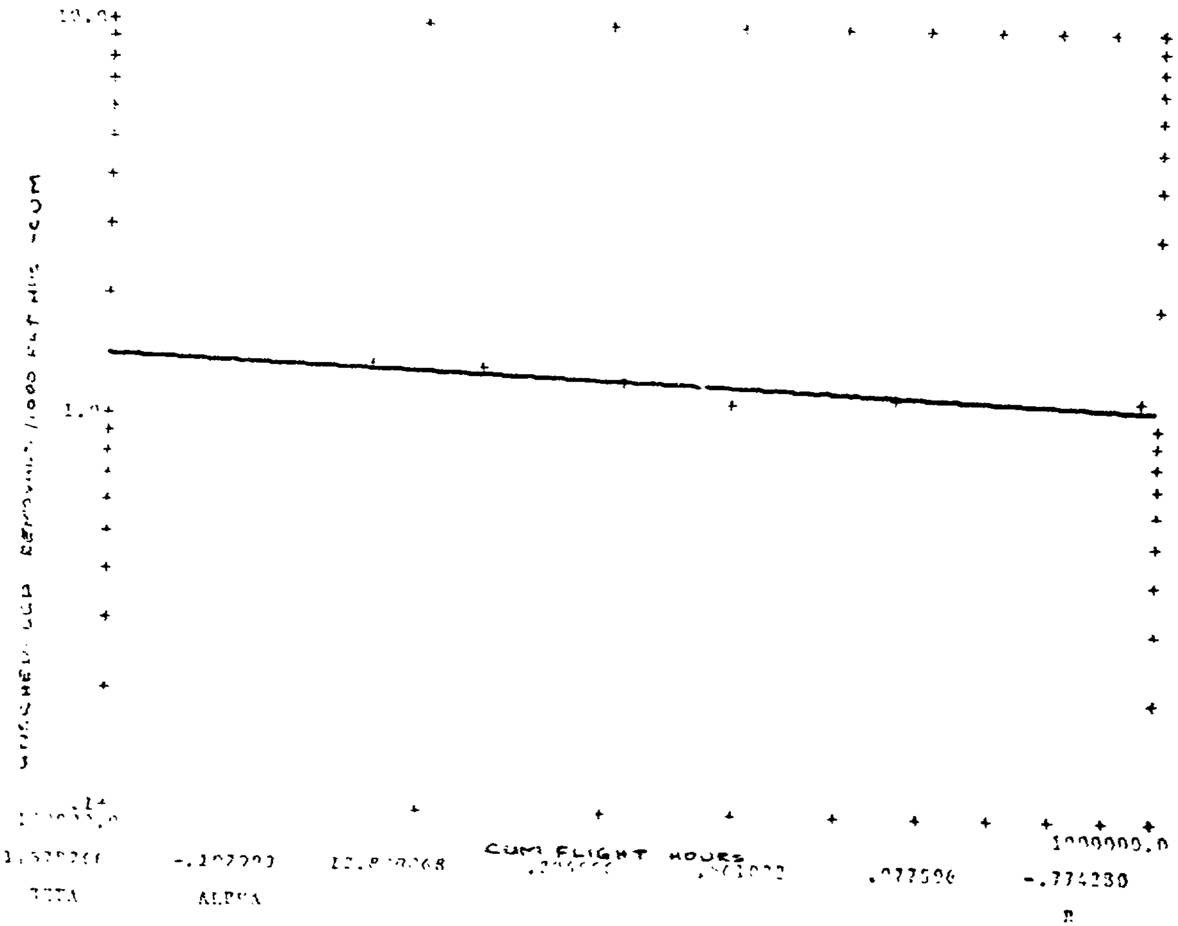


-0.135127 .646365 .720752

BETA ALPHA R

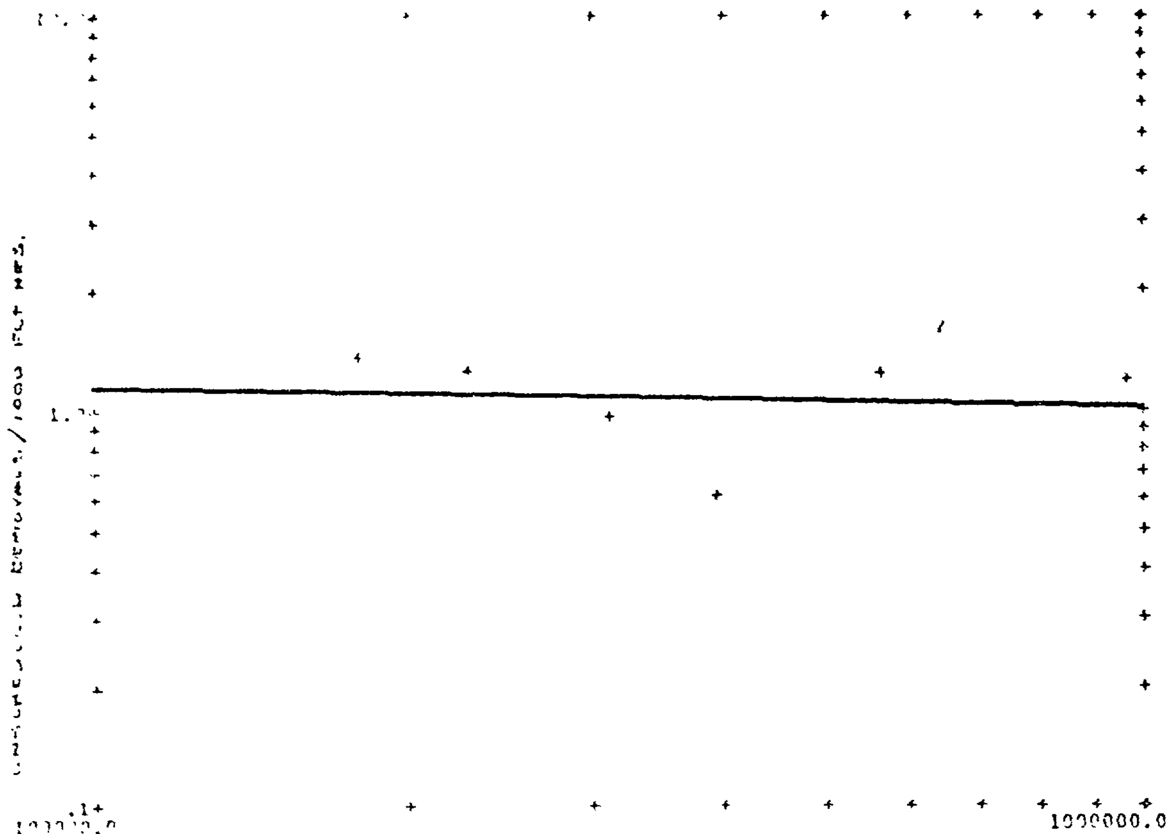
CH-46 FWD. ROTOR HEA 'D'

FIGURE 123



CH-46 AFT ROTOR HEAD 'A & B'

FIGURE 154



[illegible] | −.0[illegible] | [illegible] | [illegible] | [illegible] | .2[illegible] | −.115043

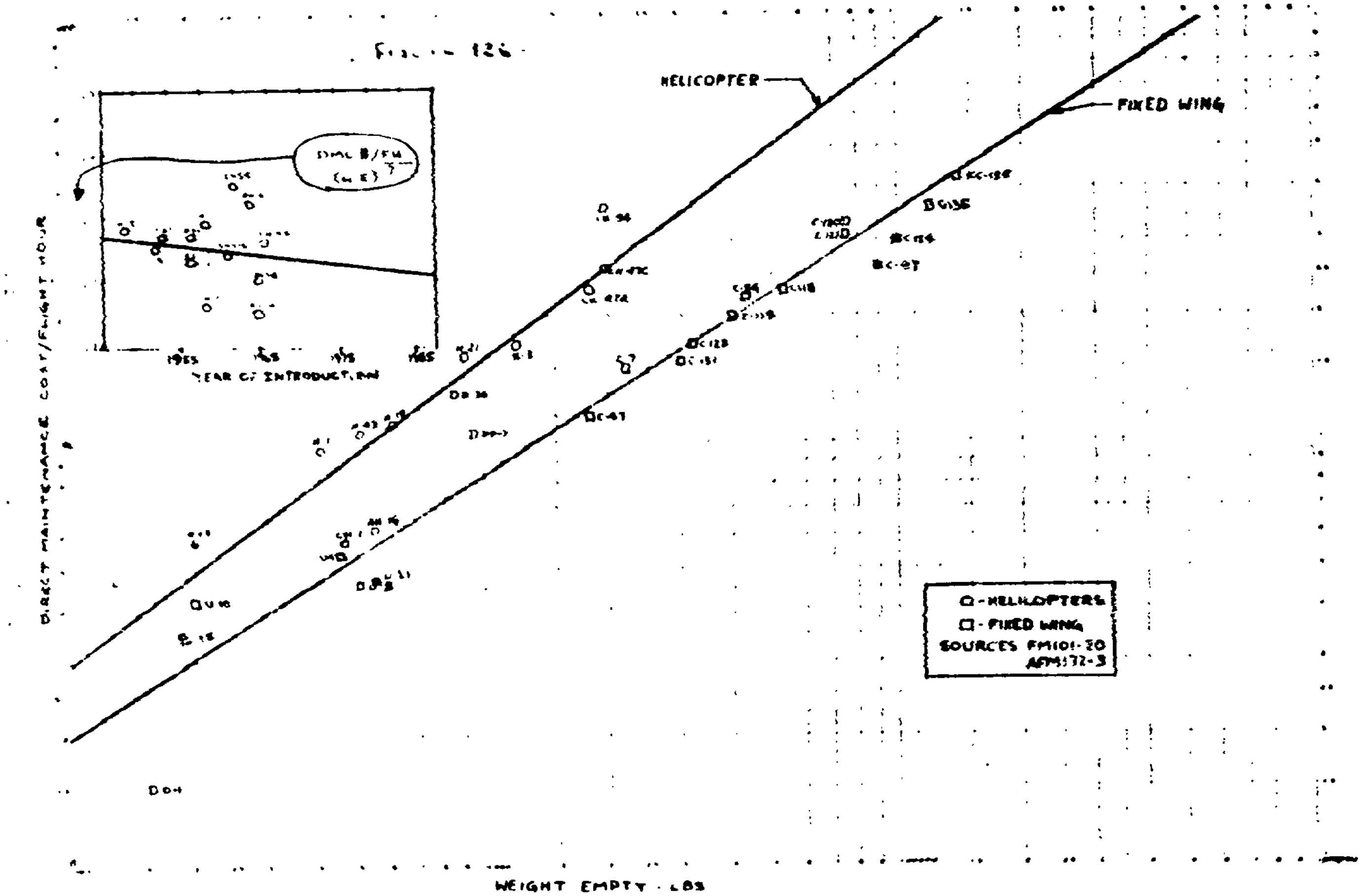
BETA ALPHA R

CH-46 AFT ROTOR HEAD A & D

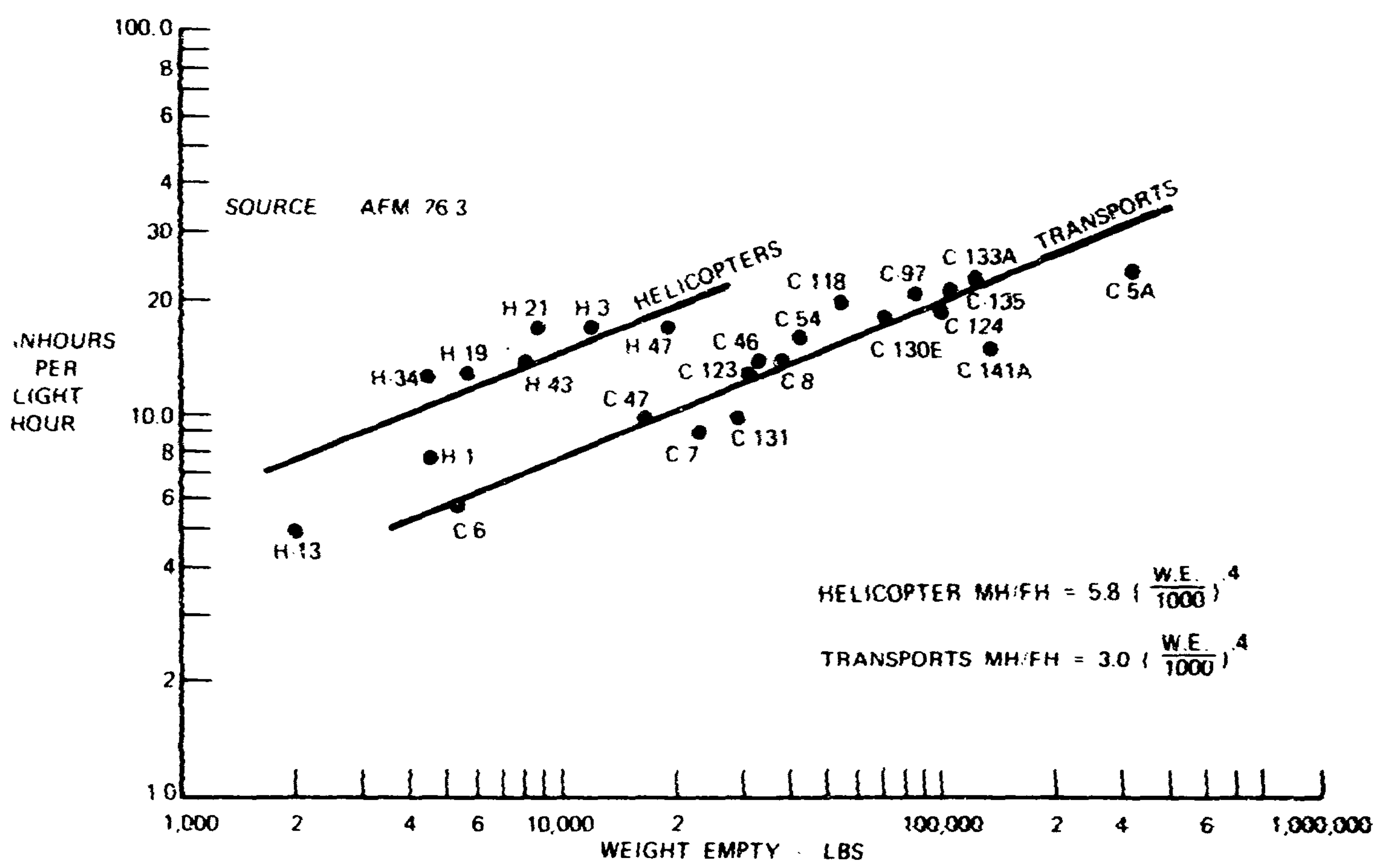
FIGURE 125

TABLE 13 - CH-46 COMPONENT R GROWTH PARAMETERS

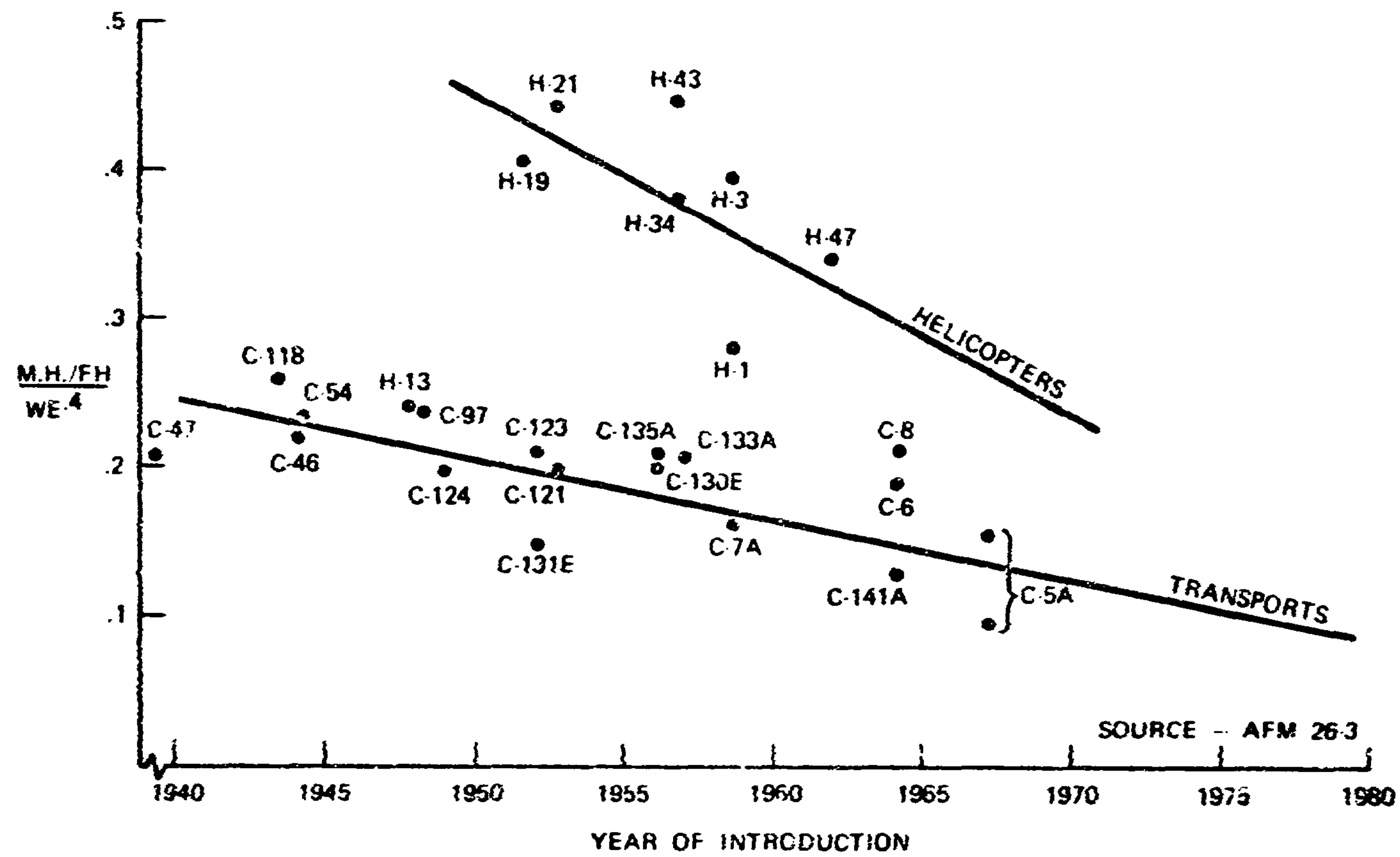
COMPONENT	UNS. REM/1000 FLT. HRS -CUM			UNS. REM./1000 FLT. HRS.		
	B	α	R	B	α	R
AFT XMSN.	4.403	-.284	-.961	8.183	-.595	-.864
FORWARD XMSN.	-3.367	.86	.729	-3.179	.177	.201
FWD ROTOR HEAD 'A'	-1.957	.190	.974	-3.181	.296	.730
FWD. ROTOR HEAD 'D'	-9.294	.709	.961	-8.105	.646	.721
AFT ROTOR HEAD 'A&D'	1.579	-.107	-.774	.791	-.056	-.115


HELICOPTER
FIXED WING
O - HELICOPTERS
□ - FIXED WING
SOURCES FM101-20
AFM172-3
YEAR OF INTRODUCTION
DIRECT MAINTENANCE COST/FLIGHT HOUR
WEIGHT EMPTY - LBS

USAF HELICOPTER & TRANSPORT MAINTENANCE



USAF HELICOPTER & TRANSPORT MAINTENANCE



Part B

Data Submitted by Hughes

YOH-6 AND OH-6A

HELICOPTER RELIABILITY STUDY

HUGHES HELICOPTERS

CULVER CITY, CALIFORNIA

PREPARED BY: P. B. LYONS
RELIABILITY ENGINEER

APPROVED BY: C. E. DAVIS
SUPERVISOR
RELIABILITY & MAINTAINABILITY

HELICOPTER RELIABILITY STUDY

ARPA TASK ORDER T-105

PURCHASE ORDER NO. 20434 - HUGHES HELICOPTERS

2 December 1974

IDA PROJECT T-105

TABLE OF CONTENTS

1.0 INTRODUCTION

This report provides OH-6A Prototype and early Production Helicopter flight test hours and failure data as required under IDA project T-105 (IDA Purchase Order 20434). These data are presented in the following manner:

a. Failures in each IDA subsystem category.
b. Failure types in three categories: Mission, Flight Safety and System (Unscheduled Maintenance Actions).
c. Failure totals and failure rates per flight hour.
d. A monthly breakdown of flight hours and failures is presented when such information was available.
e. Maintenance manhours per flight hour data are provided when such information was available.

2.0 DATA SOURCES

2.1 PROTOTYPE YOH-6 IDENTIFICATION

The prototype aircraft are identified in the following table. Note that the flight hours given are from first flight thru May 24, 1966 which is the date of the first flight of production aircraft No. 1 (65-12916).

AIRCRAFT NO.	DATE OF FIRST FLIGHT	TOTAL TIME THRU 5/24/66
1 Static Tests Only		
2 (N9696F)	2/27/63	767*
3 (N9697F)	4/11/63	264
4 (N9698F,62-12624)	6/2/63	403
5 (N9699F,62-4216)	9/23/63	720 **
6 (62-4211)	1/20/64	1269
7 (62-4212)	2/25/64	324
8 (62-4213)	3/13/64	810
9 (62-4214)	4/9/64	309
10 (62-4215)	4/30/64	608
	TOTAL	5474

* Tie-down endurance vehicle; flown 13 hours prior to start of endurance tests.
** Detailed data provided for 8[illegible]7 hours.

2.2 PROTOTYPE DATA SOURCES

The prototype aircraft were flown in various tests at many scattered locations during the time period in question. The result is that the available historical data regarding maintenance, flight hours, and failure rates is fragmented. The best sources proved to be that for ships maintained at Culver City and for the competitive fly-off tests which were more closely observed and reported. The day-to-day Culver City maintenance and flight records for YOH-6 No. 3 and No. 5 were located and used. Competitive fly-off tests at Fort Rucker

(Logistical Evaluation and Tactical Suitability) provided total flight hour and failure data for YOH-6 No. 6 and No.8. The combined flight time for these four aircraft is 2300 hours and provides a representative sample. The competitive fly-off tests are described in paragraphs following:

2.2.1 Logistical Evaluation Test

Prototype No. 6 was flown to Fort Rucker in Feb. 1964 and began flight test which accumulated 1000 hours by June of that year.

The primary purpose of the test was to evaluate parts failures and replacement requirements when the aircraft was flown on an accelerated program. The flight periods were scheduled for 2½ hours with a 15 minute turnaround. Four mission profiles were used which included nearly every type of flight that can be performed with a helicopter. In all, a total of 3867 landings and takeoffs were made during the 1000 hr. test period. This type of flying quickly brought any subsystem or component deficiencies to light.

Secondary pruposes of the test were an evaluation of the preliminary MAC, component replacement schedules, mechanics training, and both standard and special tool requirements.

2.2.2 Tactical Suitability Test

This test was also performed at Fort Rucker using Prototype No. 8 primarily and No. 10 for a short period. The tests were conducted from March thru June of 1964 and were intended to check the OH-6 within the whole tactical environment. An engineering system of ratings was used in making evaluations. Tests included transportability, ground handling and hoisting, ease of maintenance, manhours required for replacement of major components, avionics suitability, flight characteristics and mission suitability. The preliminary MAC was evaluated as was personnel requirements. The flight evaluations required 230 flight hours.

2.3 PROTOTYPE TRACKING

Efforts to locate the YOH-6 aircraft and data were non-productive in general. However, the following history was derived from the memories of Hughes personnel who were present during the period.

No. 1 Static Tests Only

No. 2 (N9696F) Was flown 13 hours and then tied down in a whirl cage at Culver City for endurance tests. The aircraft was not moved at conclusion of tests and the airframe is still in place.

No. 3 (N9697F) Underwent general testing at Culver City and armament firing at Camp Pendelton and Twenty-nine Palms. Crashed during low level firing run when the pilot inadvertently flipped a fuel switch instead of a gun safety switch. Aircraft was totaled. Pilot and passenger suffered minor injuries.

No. 4	(N9698F, 62-12624)	This aircraft is believed to have undergone flight testing at Wright Patterson. Present whereabouts unknown.
No. 5	(N9699F, 62-4216)	Underwent extensive testing primarily from the Culver City base. Tests included FAA certification. Present whereabouts unknown.
No. 6	(62-4211)	This aircraft was used in log-evaluation (1000 hour) tests at Fort Rucker; was later sent to Fort Bragg and may presently be at Wright Patterson.
No. 7	(62-4212)	Underwent tests at Edwards AFB. Tests were primarily of an engineering evaluation type to provide data for the Pilots Flight Handbook. Suffered a tail boom chop during high altitude tests and was rebuilt. Present whereabouts unknown.
No. 8	(62-4213)	Flown at Edwards AFB and later was used in Tactical Suitability Tests at Fort Rucker. This aircraft was flown in record breaking speed and endurance runs and is believed to be in a museun at Fort Rucker now.
No. 9	(62-4214)	Was flown at Edwards AFB, Bakersfield, and Yuma. Last known location was Aberdeen, Wash.
No. 10	(62-4215)	Was used in armament testing at Fort Rucker and Hunter-Ligget. Suffered a blade strike (trees) but was not badly damaged. Later was shipped to Paris for the Airshow. Present location unknown.

2.4 PRODUCTION OH-6A IDENTIFICATION

Production aircraft for which data are provided in this report are identified in the following table. Such history as is available is provided.

HUGHES PROD. NO.	ARMY SER. NO.	DELIVERY DATE	HISTORY
1	65-12916	10/66	Used in Stateside general testing and training. No. 3 & 6 later suffered crash damage and were repaired at HTC. No. 2 & 8 are bailed; No. 2 at HTC, No. 4 was destroyed in a crash.
2	65-12917	10/66	
3	65-12918	10/66	
4	65-12919	10/66	
6	65-12921	10/66	
8	65-12923	12/66	
10	65-12925	12/66	
11	65-12926	12/66	
12	65-12927	12/66	
14	65-12929	1/67	Used in R&M demo. (ARU). No. 15 later destroyed in a crash.
15	65-12930	2/67	
25	65-12940	2/67	Used in confirmatory tests (AKN). No. 25, 29 & 31 later suffered crash damage and were repaired at HTC.
29	65-12944	4/67	
31	65-12946	4/67	
40	65-12955	4/67	
50	65-12965	5/67	

2.5 PRODUCTION DATA SOURCES

Data sources for production OH-6A are the R&M Demonstration (Fort Rucker), Confirmatory Tests (Fort Knox) and Hughes Service and Operation Reports from the field. Additional description of source data follows:

2.5.1 R&M Demonstration

The R&M (reliability and maintainability) demonstration tests were performed at Fort Rucker during the period of Feb, 1967 thru Aug, 1967. Production aircraft No. 14 and No. 15 were each flown a total of 500 hours. Close records were kept of all failures which were divided into three categories, Mission, Flight Safety, and System. The failures in each category were charged to the major subsystem (8 total) as appropriate. Nine different mission profiles were flown during this program to provide a representative sample of all expected normal flights of the aircraft.

Maintenance manhour records were kept for all maintenance actions during the program and notations are provided as to the chargeable or non-chargeable nature of the actions. Non-chargeable maintenance actions are those concerning GFE (engine and avionics), actions due to incorrect maintenance practice, and accident or incident damage.

2.5.2 Confirmatory Test Data

Confirmatory tests were conducted at Fort Knox during the period from Sept. 1967 thru June 1968. Five aircraft, (Prod No. 25, 29, 31, 40 and 50) were flown during the tests for a total of 5269 hours.

In these tests, primary concern was the pinpointing of problem subsystems and components, the development of solutions for these problems, and confirmation of the "fix" with resultant increase in reliability.

The data available provides system and component total failures without notation as to which may have been classed as mission failures. An assumption can be made however [illegible] judgement of the nature of the failure. The data are not divided into calendar periods as regards flight hours or maintenance actions.

2.5.3 Additional Production Helicopter Data

Data was extracted from Service and Operation Reports for nine production helicopters listed in Paragraph 2.4. The data for these aircraft covers the period from delivery through October, 1967; a total of over 4000 hours. The cut-off date, and those particular aircraft, were chosen because of their engagement in test or training activities within the United States. Dates

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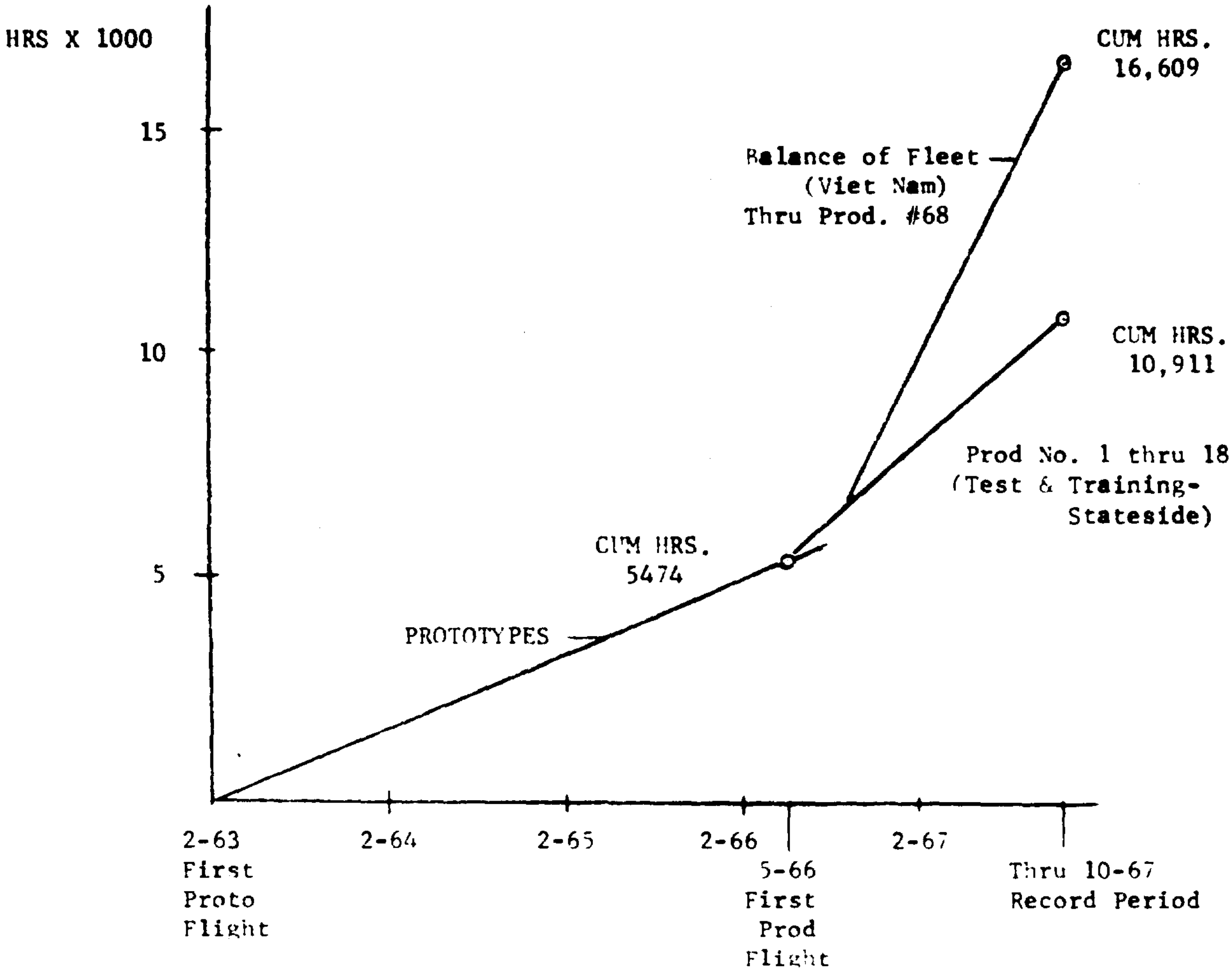


FIGURE 2-1 TOTAL FLEET HOURS FOR RECORD PERIOD

beyond this period, and later aircraft, do not provide a representative sample due to wartime activities. However, a graph of the total OH-6 fleet hours for the record period is provided in figure 2-1. The failure rate data is provided only in terms of total failures and flight hours. Monthly breakdown information is not available.

3.0 SUBSYSTEM CATEGORIES

IDA subsystem categories used in this report include Hughes subsystems as shown in the following chart:

IDA SUBSYSTEM CATEGORY	HUGHES SUBSYSTEMS
Complete helicopter	01 Complete Helicopter
Rotors	10 Main Rotor
	16 Tail Rotor
Airframe Components	20 Fuselage
	35 Tail Boom
	36 Stabilizer
	40 Utility Equipment
	60 Landing Gear
	70 Flight Controls
Transmissions and Drives	50 Drive System
Power Plant	77 Engine Controls
	80 Power Plant
	81 Fuel System
	82 Exhaust
	83 Oil System
Instruments	41 Electrical
	42 Exterior-Interior Lighting
	45 Instruments
Communications	44 Radio
Weapon Systems	47 Armor, Armament

4.0 CRITERIA AND DEFINITIONS

The following criteria were used in preparing this report. Abbreviations used in the tables are also defined.

FS - Flight-Safety failures of the catastrophic type

MSN - Mission failures of the type causing cancelled flight plan, premature return-to-base, or precautionary landing.

SYS - System failures are unscheduled maintenance actions due to pilots squawks or defects found during inspections. Includes items for which maintenance may be deferred without creating a flight safety hazard.

[illegible] - Failure rate per flight hour.

C - Chargeable items are all qualifying failures listed above.

NC - Non-chargeable items include parts removed for access to faulty parts, parts removed in error during fault isolation, parts damaged due to incorrect maintenance practices, cannibalization, accident damage, and scheduled (TBO) removals.

CUM - Cumulative

LOC - Location during test period:

AAB - Aberdeen or Phillips AAB
AKN - Fort Knox
ARU - Fort Rucker
EAF - Edwards AFB
HTC - Hughes, Culver City

5.0 SUMMARY

5.1 PROTOTYPE DATA SUMMARY

			FAILURES				
SHIP NO.	LOC.	FLT. HRS.	MSN	FS	SYS	CUM	FR/FH
3	HTC	264	8	0	105	113	0.4280
5	HTC	807	18	0	331	349	0.4325
6 .	ARU	1000	17	0	76	93	* 0.0930
8	ARU	230	9	0	93	102	0.4434
TOTALS (all)		2301	52	0	605	657	0.2855
TOTALS (excluding # 6)		1301	35	0	529	564	0.4335

Failure rates for Ship 6 appear low when compared to other prototype aircraft. This is possibly due to the type of testing performed. Records used are for the 1000 hour log evaluation test at Fort Rucker. The flight time there was accumulated as quickly as possible and deferrable type maintenance actions may not have been recorded. GFE failures (engine and communications equipment) were not recorded or charged. Refer to Table 6-5 for system details.

The data for ships No. 3, 5, and 8 were derived from day-to-day records and include all GFE. Some difficulty was experienced in determining which maintenance actions were due to failures and which were work requirements for specific tests. Bias, if any, is toward the high failure rate side. Refer to tables 6-1 through 6-4 and 6-6 for detailed data.

5.2 R & M DATA SUMMARY (PRODUCTION)

SHIP NO.	LOC.	FLT HRS.	FAILURES MSN	FS	SYS	CUM	FR/FH
12929	ARU	500	8	0	154	162	0.3240
12930	ARU	500	8	0	190	198	0.3960
TOTALS:		1,000	16		344	360	0.3600

Refer to tables 6-7 through 6-10 for detailed data. GFE failures were not recorded or charged.

5.3 CONFIRMATORY DATA SUMMARY (PRODUCTION)

SHIP NO.	LOC	FLT HRS.	FAILURES MSN	FS	SYS	CUM	FR/FH
12940	AKN	1,032					
12944	AKN	1,068					
12946	AKN	1,037					
12955	AKN	1,053					
12965	AKN	1,077					
TOTALS:		5,269	73	0	972	1,045	0.1983

Refer to table 6-11 for details. The data includes GFE failures. A monthly breakdown for these particular tests is not available.

5.4 ADDITIONAL DATA SUMMARY (PRODUCTION)

SHIP NO.	LOC.	FLT HRS.	FAILURES MSN	FS	SYS	CUM	FR/FH
12916	ARU	474	12	0	39	51	0.1075
12917	HTC	183	6	0	13	19	0.1038
12918	ARU	564	10	0	37	47	0.0833
12919	EAF	286	11	0	79	90	* 0.3147
12921	ARU	900	20	0	84	104	0.1156
12923	ARU	352	2	0	15	17	** 0.0483
12925	ARU	483	5	0	16	21	** 0.0435
12926	ARU	652	6	0	16	22	** 0.0352
12927	AAB	132	5	0	19	24	0.1818
TOTALS (ALL)		4,026	77		318	395	0.0981

* The failure rate data for this aircraft appears high, placing it in the same category as the prototype and R&M ships. The type of testing undergone at Edwards AFB is unknown, as are the criteria used in defining failures.

** The failure rate data for these aircraft appears low and outside the general pattern. The cause is probably inadequate reporting during the time period. When the questionable data are excluded from the totals (table below) the failure rate per flight hour is lowered. However, the first total including all "good" and "bad" data may be closer to the general average.

FLT HRS.	FAILURES MSN	FS	SYS	CUM	FR/FH
2,905	59	0	208	267	0.0919

Refer to tables 6-12 and 6-13 for details of the data used, GFE failures (Avionics) are not included and a monthly breakdown is not available.

6.0 DETAILED DATA TABLES

Refer to tables 6-1 through 6-13 following.

TABLE 6-1 PROTOTYPE DATA (SHIP NO. 3)

MONTH	FLIGHT HOURS	CUM FLIGHT HOURS	FAILURES (CHARGEABLE) MSN	FS	SYS	CUM TOTAL	FR/FH
4/63	9.8	9.8	1	0	9	10	0.9800
5/63	19.9	29.7	2	0	11	23	0.8417
6/63	12.1	41.8	0	0	11	34	0.8612
7/63	33.0	74.8	0	0	11	45	0.6283
8/63	24.5	99.1	2	0	14	61	0.6357
9/63	23.0	122.1	0	0	9	70	0.5896
10/63	6.4	128.5	0	0	2	72	0.5758
11/63	33.8	162.3	2	0	9	83	0.5237
12/63	25.5	187.8	0	0	12	95	0.5165
1/64	20.8	208.6	0	0	4	99	0.4842
2/64	18.1	226.7	0	0	3	102	0.4587
3/64	13.7	240.4	0	0	2	104	0.4409
4/64	17.2	257.6	1	0	8	113	0.4386
5/64	6.8	264.4	0	0	1	114	0.4374

* Crashed during armament tests--Pilot error

TABLE 6-2 PROTOTYPE DATA (SHIP NO. 3)

TOTAL FAILURES PER SUBSYSTEM

C = CHARGEABLE
NC = NON CHARGEABLE

SUB SYS. CATEGORY		MONTH 4/63	5/63	6/63	7/63	8/63	9/63	10/63	11/63	12/63	1/64	2/64	3/64	4/64	5/64	TOTAL
COMPLETE HELICOPTER	C	10	13	11	11	16	9	2	11	12	4	3	2	9	1	114
	NC	1	2	2	2	2	0	0	2	0	0	0	0	0	0	11
ROTORS	C	1	3	3	3	1	1	1	0	1	0	0	0	1	0	15
	NC	1	2	2	2	1	0	0	0	0	0	0	0	0	0	8
AIRFRAME COMPS	C	1	1	0	3	7	3	0	6	5	1	1	2	3	0	33
	NC	0	0	0	0	1	0	0	2	0	0	0	0	0	0	3
XMSN & DRIVES	C	0	1	1	2	3	0	0	1	0	1	0	0	1	1	11
	NC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
POWER PLANT	C	6	4	4	2	3	2	1	3	3	0	1	0	3	0	32
	NC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
INST. & ELEC.	C	0	4	3	1	2	3	0	0	3	2	0	0	1	0	19
	NC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
COMMUNICATIONS	C	2	0	0	0	0	0	0	1	0	0	0	0	0	0	3
	NC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WEAPON SYSTEMS	C	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
	NC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL REMOVALS	C	5	6	7	5	6	6	1	8	10	3	0	2	7	1	67
	NC	1	2	2	2	2	0	0	0	1	0	2	0	0	0	12

TABLE 6-3 PROTOTYPE DATA (SHIP NO. 5)

MONTH	FLIGHT HOURS	CUM FLIGHT HOURS	FAILURES MSX	FS	SYS	CUM TOTAL	FR/FH
9/63	4.5	4.5	0	0	7	7	1.5555
10/63	21.7	26.2	1	0	15	23	0.8778
11/63	26.5	52.7	0	0	8	31	0.5882
12/63	5.0	57.7	2	0	12	45	0.7798
1/64	55.8	113.5	2	0	21	68	0.6017
2/64	33.9	147.4	1	0	13	82	0.4833
3/64	17.0	164.4	1	0	15	98	0.5918
4/64	22.0	186.4	0	0	12	110	0.5863
5/64	49.5	235.9	0	0	17	127	0.5140
6/64	112.7	348.6	2	0	18	147	0.3964
7/64	38.2	386.8	1	0	18	166	0.4090
8/64	24.3	411.1	0	0	9	175	0.4067
9/64	26.6	437.7	1	0	19	195	0.4300
10/64	1.4	439.1	0	0	3	198	0.4354
11/64	18.4	457.5	0	0	7	205	0.4354
12/64	10.9	468.4	0	0	2	207	0.4380
1/65	6.1	474.5	0	0	3	210	0.4387
2/65	1.2	475.7	0	0	2	212	0.4418
3/65	34.0	509.7	1	0	5	218	0.4238
4/65	23.2	532.9	0	0	6	224	0.4166
5/65	3.9	536.8	0	0	3	227	0.4192
6/65	4.1	540.9	0	0	2	229	0.4198
7/65	9.2	550.1	0	0	3	232	0.4182
8/65	15.5	565.6	1	0	8	241	0.4227
9/65	11.1	576.7	0	0	4	245	0.4215
10/65	6.4	583.1	0	0	3	248	0.4220
11/65	9.0	592.1	1	0	5	254	0.4258
12/65	8.8	600.9	0	0	3	257	0.4245
1/66	11.2	612.1	1	0	10	268	0.4349
2/66	28.0	640.1	0	0	4	272	0.4219
3/66	18.8	658.9	1	0	6	279	0.4206
4/66	11.8	670.7	0	0	5	284	0.4205
5/66	25.8	696.5	1	0	6	291	0.4149
6/66	12.2	708.7	0	0	5	296	0.4148
7/66	6.0	714.7	0	0	1	297	0.4127
8/66	4.1	718.8	0	0	3	300	0.4146
9/66	16.8	735.6	0	0	3	303	0.4091
10/66	32.5	768.1	1	0	5	309	0.4127
11/66	0.0	768.1	0	0	7	316	0.4219
12/66	0.0	768.1	0	0	7	323	0.4311
1/67	36.6	804.7	0	0	1	324	0.4125
2/67	1.8	806.5	0	0	1	325	0.4129
3/67	0.0	806.5	0	0	17	342	0.4329
4/67	11.0	817.5	0	0	4	346	0.4320
			18	0	328		

Periodic Inspection
Inspection following transfer of aircraft
Conformity inspection

TABLE 6-2 PROTOTYPE DATA (SHIP NO. 3)

TOTAL FAILURES PER SUBSYSTEM

SYS. CATEGORY	C - CHARGEABLE NC - NONCHARGEABLE	4/63	5/63	6/63	7/63	8/63	9/63	10/63	11/63	12/63	1/64	2/64	3/64	4/64	5/64	TOTAL
COMPLETE HELICOPTER	C	10	13	11	11	16	9	2	11	12	4	3	2	9	1	114
	NC	1	2	2	2	2	0	0	2	0	0	0	0	0	0	11
ROTORS	C	1	3	3	3	1	1	1	0	1	0	0	0	1	0	15
	NC	1	2	2	2	1	0	0	0	0	0	0	0	0	0	8
AIRFRAME COMPS	C	1	1	0	3	7	3	0	6	5	1	1	2	3	0	33
	NC	0	0	0	0	1	0	0	2	0	0	0	0	0	0	3
XMSN & DRIVES	C	0	1	1	2	3	0	0	1	0	1	0	0	1	1	11
	NC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
POWER PLANT	C	6	4	4	2	3	2	1	3	3	0	1	0	3	0	32
	NC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
INST. & ELEC.	C	0	4	3	1	2	3	0	0	3	2	0	0	1	0	19
	NC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
COMMUNICATIONS	C	2	0	0	0	0	0	0	1	0	0	0	0	0	0	3
	NC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WEAPON SYSTEMS	C	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
	NC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL REMOVALS	C	5	6	7	5	6	6	1	8	10	3	0	2	7	1	67
	NC	1	2	2	2	2	0	0	0	1	0	2	0	0	0	12

TABLE 6-4 PROTOTYPE DATA (SHIP NO. 5) Sheet 1 of 3
TOTAL FAILURES PER SUBSYSTEM

SUB SYS. CATEGORY	C = CHARGEABLE NC = NON CHARGEABLE	9/63	10/63	11/63	12/63	1/64	2/64	3/64	4/64	5/64	6/64	7/64	8/64	9/64	10/64	11/64	12/64	1/65
COMPLETE HELICOPTER	C	7	16	8	14	23	14	16	12	17	20	19	9	20	3	7	2	3
	NC	5	8	8	5	7	5	5	4	5	6	5	0	5	0	2	1	0
ROTORS	C	0	3	3	3	5	3	2	2	4	3	2	2	3	1	2	0	0
	NC	1	6	2	2	3	0	0	1	1	1	0	0	0	0	1	1	0
AIRFRAME COMPS.	C	4	5	2	5	12	5	5	6	5	3	6	6	9	1	2	1	1
	NC	1	0	1	2	4	2	2	2	2	1	1	0	4	0	0	0	0
XMSN & DRIVES	C	2	4	0	1	0	1	1	0	1	0	0	0	2	0	1	1	0
	NC	1	2	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0
POWER PLANT	C	0	0	2	3	2	2	4	4	4	10	6	1	2	1	2	0	1
	NC	0	0	3	0	0	0	1	1	2	4	2	0	1	0	1	0	0
INST. & ELEC.	C	1	2	1	2	4	2	4	0	1	4	5	0	4	0	0	0	1
	NC	2	0	1	0	0	2	2	0	0	0	2	0	0	0	0	0	0
COMMUN-ICATIONS	C	0	2	0	0	0	1	0	0	2	0	0	0	0	0	0	0	0
	NC	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WEAPON SYSTEMS	C		NO WEAPONS INSTALLED															
	NC																	
TOTAL REMOVALS	C	0	7	7	11	11	9	9	5	12	14	12	4	7	1	3	1	0
	NC	2	4	3	6	3	3	2	1	2	4	3	0	2	0	1	0	0

TABLE 6-4 PROTOTYPE DATA (SHIP NO. 5) Sheet 2 of 3

TOTAL FAILURES PER SUBSYSTEM

C = CHARGEABLE
NC = NON CHARGEABLE

SUB SYS. CATEGORY		2/65	3/65	4/65	5/65	6/65	7/65	8/65	9/65	10/65	11/65	12/65	1/66	2/66	3/66	4/66	5/66	6/66
COMPLETE HELICOPTER	C	2	6	6	3	2	3	9	4	3	6	3	11	4	7	5	7	5
	NC	0	0	0	0	0	0	1	0	0	1	3	3	0	0	1	3	3
ROTORS	C	0	1	0	1	0	2	2	1	1	1	1	2	2	1	1	1	0
	NC	0	0	0	0	0	0	0	0	0	1	1	1	0	0	1	1	3
AIRFRAME COMPS.	C	2	2	3	0	0	1	3	1	1	3	0	6	1	2	1	1	2
	NC	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
XMSN & DRIVES	C	0	0	0	1	0	0	1	1	0	1	1	1	1	2	0	0	0
	NC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
POWER PLANT	C	0	1	1	0	0	0	1	0	0	1	0	1	0	1	2	4	2
	NC	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	1	0
INSTS. & ELEC.	C	0	2	1	1	1	0	2	1	1	0	1	1	0	1	1	1	1
	NC	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	1	0
COMMUN-ICATIONS	C	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	NC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WEAPON SYSTEMS	C	NO WEAPONS INSTALLED																
	NC																	
TOTAL REMOVALS	C	1	2	2	3	0	1	4	2	0	3	1	3	2	5	2	5	2
	NC	0	0	0	0	0	0	1	0	0	1	1	1	0	0	1	2	3

TABLE 6-4 PROTOTYPE DATA (SHIP NO. 5)

TOTAL FAILURES PER SUBSYSTEM

SUB SYS. CATEGORY	C = CHARGEABLE NC = NON CHARGEABLE	7/66	8/66	9/66	10/66	11/66	12/66	1/67	2/67	3/67	4/67	TOTAL	
		MONTH											
COMPLETE HELICOPTER	C	1	3	3	6	7	7	1	1	17	4	346	
	NC	1	0	0	1	0	0	0	0	0	0	88	
ROTORS	C	0	0	1	1	1	0	1	0	1	1	61	
	NC	1	0	0	0	0	0	0	0	0	0	28	
AIRFRAME COMPS.	C	1	1	2	1	5	7	0	0	8	1	133	
	NC	0	0	0	1	0	0	0	0	0	0	24	
XMSN & DRIVES	C	0	0	0	0	0	0	0	0	0	0	23	
	NC	0	0	0	0	0	0	0	0	0	0	5	
POWER PLANT	C	0	1	0	1	0	0	0	0	3	0	63	GFE INCLUDED
	NC	0	0	0	0	0	0	0	0	0	0	18	
INSTS. & ELEC.	C	0	1	0	2	1	0	0	1	4	2	57	
	NC	0	0	0	0	0	0	0	0	0	0	12	
COMMUN-ICATIONS	C	0	0	0	1	0	0	0	0	1	0	9	
	NC	0	0	0	0	0	0	0	0	0	0	1	
WEAPON SYSTEMS	C		NO WEAPONS INSTALLED										
	NC												
TOTAL REMOVALS	C	0	0	3	3	1	0	0	0	5	1	164	
	NC	0	0	0	0	0	0	0	0	0	0	46	

TABLE 6-5 PROTOTYPE DATA (SHIP NO. 6)
TOTAL FAILURES PER SUBSYSTEM

SUB SYS. CATEGORY	C = CHARGEABLE NC = NON CHARGEABLE			RECORD PERIOD - FEB. 1964 THRU JUNE 1964 - 1000 FLIGHT HRS. Unsched. M H	Sched. M H	Total	MH/FH
COMPLETE HELICOPTER	C	93		342.5	186.8	529.3	0.529
ROTORS	C	28		24.6	48.4	73.0	0.073
AIRFRAME COMPS.	C	29		186.4	65.7	252.0	0.252
XMSN & DRIVES	C	8		54.8	25.8	80.6	0.081
POWER PLANT	C	8	EXCLUDES G F E	17.1	24.0	41.1	0.041
INSTS & ELEC.	C	20		59.5	22.8	82.3	0.083
COMMUN-ICATIONS			G F E - NOT REPORTED				
WEAPON SYSTEMS			- NOT REPORTED				
TOTAL REMOVALS		UNKNOWN					

TABLE 6-6 PROTOTYPE DATA (SHIP NO. 8)
TOTAL FAILURES PER SUBSYSTEM

SUB SYS. CATEGORY	C = CHARGEABLE NC = NON CHARGEABLE	RECORD PERIOD - 3/64 thru 6/64
COMPLETE HELICOPTER	C	102
	NC	20
ROTORS	C	19
	NC	6
AIRFRAME COMPS	C	23
	NC	5
XMSN & DRIVES	C	4
	NC	2
POWER PLANT	C	20
	NC	4
INSTS. & ELEC.	C	28
	NC	3
COMMUN-ICATIONS	C	8
	NC	0
WEAPON SYSTEMS	NOT REPORTED	
TOTAL REMOVALS	C	41
	NC	16

TABLE 6-7 R&M DATA (65-12929)

MONTH	FLIGHT HOURS	CUM FLIGHT HOURS	FAILURES MSN	FS	SYS	CUM TOTAL	FR/FH
2/67	18.8	18.8	0	0	0	0	
3/67	146.2	165.0	2	0	13	15	0.0909
4/67	33.3	198.3	1	0	3	19	0.0958
5/67	104.1	302.4	2	0	55	76	0.1818
6/67	142.6	445.0	2	0	51	129	* 0.2898
7/67	0.0	445.0	-	-	13	142	0.3191
8/67	55.0	500.0	1	0	19	162	0.3240

* Periodic Inspection

Total man hours = Scheduled + Unscheduled = 308.2

Maint. man hours per flight hours = 308.2/500 = 0.616 Hr.

TABLE 6-8 R&M DATA (65-12929)
TOTAL FAILURES PER SUBSYSTEM

SUBSYS. CATEGORY — C = CHARGEABLE; NC = NON CHARGEABLE

SUBSYS. CATEGORY		MONTH 2/67	3/67	4/67	5/67	6/67	7/67	8/67	TOTAL
COMPLETE HELICOPTER	C	0	15	4	57	53	13	20	162
	NC	0	3	1	7	9	0	1	21
ROTORS	C	0	4	1	9	8	0	2	24
	NC	0	1	0	2	2	0	0	5
AIRFRAME COMPS	C	0	7	1	23	21	5	7	64
	NC	0	2	0	4	5	0	0	11
XMSN & DRIVES	C	0	0	0	3	1	2	3	9
	NC	0	0	0	0	1	0	1	2
POWER PLANT	C	0	1	1	7	11	3	2	25 EXCLUDES G F E
	NC	0	0	1	1	1	0	0	3
INSTS. & ELEC.	C	0	3	1	15	12	3	6	40
	NC	0	0	0	0	0	0	0	0
COMMUN-ICATIONS			G F E NOT REPORTED						
WEAPON SYSTEMS			NONE INSTALLED						
TOTAL REMOVALS	C	0	2	4	15	18	5	6	50
	NC	0	0	1	4	6	0	1	12

TABLE 6-9 R&M DATA (65-12930)

MONTH	FLIGHT HOURS	CUM FLIGHT HOURS	FAILURES MSN	FS	SYS	CUM TOTAL	FR/FH
2/67	17.3	17.3	0	0	0	0	
3/67	116.2	133.5	2	0	15	17	0.1273
4/67	74.7	208.2	2	0	20	39	0.1873
5/67	27.5	235.7	1	0	14	54	0.2291
6/67	112.4	348.1	2	0	92	148	* 0.4251
7/67	96.6	444.7	1	0	23	172	0.3867
8/67	55.6	500.3	0	0	26	198	0.3960

* Periodic Inspection

Total Manhours = Scheduled + Unscheduled = 374.8

Maint. Manhours per flight hour = 374.8/500 = 0.749 Hr.

TABLE 6-10 R&M DATA (65-12930)
TOTAL FAILURES PER SUBSYSTEM

SUB SYS. CATEGORY — C = CHARGEABLE, NC = NON CHARGEABLE

SUB SYS. CATEGORY		MONTH 2/67	3/67	4/67	5/67	6/67	7/67	8/67	TOTAL	
COMPLETE HELICOPTER	C	0	17	22	15	94	24	26	198	
	NC	0	2	0	0	0	0	0	2	
ROTORS	C	0	3	4	3	17	2	2	31	
	NC	0	0	0	0	0	0	0	0	
AIRFRAME COMPS.	C	0	5	8	7	38	13	15	86	
	NC	0	0	0	0	0	0	0	0	
XMSN & DRIVES	C	0	0	1	0	8	2	3	14	
	NC	0	0	0	0	0	0	0	0	
POWER PLANT	C	0	4	5	3	12	4	2	30	EXCLUDES G F E
	NC	0	1	0	0	0	0	0	1	
INSTS. & ELEC.	C	0	5	4	2	19	3	4	37	
	NC	0	1	0	0	0	0	0	1	
COMMUN-ICATIONS	C	G F E NOT REPORTED								
	NC									
WEAPON SYSTEMS		NONE INSTALLED								
TOTAL REMOVALS	C	0	10	5	12	34	13	10	84	
	NC	0	2	4	0	8	2	0	16	

TABLE 6-11 CONFIRMATORY DATA (PRODUCTION)
TOTAL FAILURES PER SUBSYSTEM

SUB SYS CATEGORY	C = CHARGEABLE NC = NON CHARGEABLE		
		RECORD PERIOD FROM 9/67 thru. 5/68	
COMPLETE HELICOPTER	C	1045	
	NC	155	
ROTORS	C	83	
	NC	23	
AIRFRAME COMPS.	C	283	
	NC	15	
XMSN & DRIVES	C	9	
	NC	13	
POWER PLANT	C	220	INCLUDES G F E
	NC	18	
INSTS. & ELEC.	C	222	
	NC	83	
COMMUN-ICATIONS	C	62	INCLUDES G F E
	NC	3	
WEAPON SYSTEMS	C	166	
	NC	0	
TOTAL REMOVALS	C	446	
	NC	83	

FIVE AIRCRAFT FAILURE TOTALS FOR 5269 FLT. HRS.

MAINTENANCE MANHOURS PER FLIGHT HOUR 0.877

AVAILABILITY - ACTUAL - 83.4?

TABLE 6-12 ADDITIONAL PRODUCTION DATA

SERIAL NO. 65-	FLIGHT HOURS	CUM FLIGHT HOURS	FAILURES MSN	FS	SYS	CUM TOTAL	FR/FH
Period of Record from 1966 delivery to 11/1/67							
21916		474	12	0	39	51	0.1075
21917		183	6	0	13	19	0.1038
21918		564	10	0	37	47	0.0833
21919		286	11	0	79	90	0.3147
21921		900	20	0	84	104	0.1156
21923		352	2	0	15	17	0.0483
21925		483	5	0	16	21	0.0435
21926		652	6	0	16	22	0.0352
21927		132	5	0	19	24	0.1818

TABLE 6-13 ADDITIONAL PRODUCTION DATA
TOTAL FAILURES PER SUBSYSTEM

(RECORD PERIOD FROM 1966 DELIVERY TO 11/1/67)

C = CHARGEABLE
NC = NON CHARGEABLE

SUB SYS CATEGORY Ser. No. 65-		12916	12917	12918	12919	12921	12923	12925	12926	12927	TOTAL
COMPLETE HELICOPTER	C	51	19	47	90	104	17	21	22	24	395
	NC	3	4	1	4	12	1	1	2	2	30
ROTORS	C	5	6	4	7	20	1	2	2	6	53
	NC	0	0	0	0	4	0	0	0	0	4
AIRFRAME COMPS.	C	16	5	15	35	41	8	10	11	10	151
	NC	2	1	1	4	6	0	1	1	1	17
XMSN & DRIVES	C	3	2	6	5	10	3	4	3	1	37
	NC	1	2	0	0	0	0	0	0	0	3
POWER PLANT	C	11	1	11	33	11	3	2	4	2	78
	NC	0	0	0	0	0	0	0	0	1	1
INSTS. & ELEC.	C	16	5	11	10	22	1	3	2	5	75
	NC	0	0	0	0	2	1	0	1	0	4
COMMUN-ICATIONS		G F E NOT REPORTED									
WEAPON SYSTEMS		NOT REPORTED									
TOTAL REMOVALS		UNKNOWN									

Part C

Data Submitted by Sikorsky

Sikorsky Aircraft — DIVISION OF UNITED AIRCRAFT CORPORATION

TITLE Operations Reliability Maintainability Engineering Program Quarterly Evaluation Report

REPORT NUMBER SER-64276

PREPARED UNDER Contract No. DAA-J01-68C-0512 (31) Mod P008

REPORT DATE May .., 1968

REPORT PERIOD

This report is applicable to the following aircraft model(s) and contract(s):

MODEL	CONTRACT
CH-54A	DAA-J01-68C-05.. (31) P008

Prepared by [signature] E. Holbert Checked by [signature] M. A. Wachs

Approved by [signature] D. S. Jenney

REV.	CHANGED BY	REVISED PAGE(S)	ADDED PAGE(S)	DELETED PAGE(S)	DESCRIPTION	DATE	APPROVAL
[illegible]	[illegible]				9th Quarterly Cumulative Report	15 May	70
[illegible]	[illegible]				10th Quarterly Cumulative Report	15 Aug	70
[illegible]					11th Quarterly Cumulative Report	15 Dec	70

REVISIONS CONTINUED ON NEXT PAGE

ABSTRACT

The quarterly Evaluation Report is submitted for the eleventh quarterly period of field data collection as part of the Operations Reliability/ Maintainability Engineering Program, defined in Contract DAA-J01-68C-0512 (31), Data Item 08-010, DA Form 3149-R. The data is cumulative for the 33 month period and all information not compiled in the prior reports has been included as part of up-dating for this report.

CH-54A Operations Reliability data accumulated a total of 47,993 flight hours for the 33 month period. The reliability levels for a one-hour mission based on this data are:

Total Reliability	.7845
Mission Reliability	.9875

Analysis of maintainability data shows the following derivations.

Average Active Maintenance Downtime/Flight Hour	2.3 hrs
Elapsed Mean Time to Repair	1.9 hrs
Average Manhours/Down Hour	2.8 MH
Active Maintenance Manhour/Flight	6.4 MMH/FH
Operational Availability	54.3%

The stable nature of the 2.8 manhours per down hour and 6.4 manhours per flight hour values may reflect the maturing of the program and the continuing effort to improve our computer program.

The increase in operational availability from 54.1% to 54.3% is the direct result of a decrease in reported administrative down time.

RELIABILITY ANALYSIS

SUMMARY

U. S. Army CH-54A operations in the 33 months of ORME data reporting have accumulated 47,993 flight hours and exhibit the following MTBF's (Mean Time Between Failures):

All Failures	4.1[illegible] hours
Mission Aborts	60.1 hours

These MTBF's convert to the following reliability levels for a one-hour mission:

Total Reliability*	(1 hour)	.754[illegible]
Mission Reliability**	(1 hour)	.9[illegible]5

Hardware discrepancies required 37,66[illegible] maintenance man-hours for local corrective maintenance.

Relatively few components contribute to a high percentage of the total aircraft unreliability. At the system level, powerplant, rotors and blades, transmission, instruments, hydraulics and communications account for 67.3% of all primary failures. Powerplant, APP, hydraulics and transmission a count for 73% of all mission abort failures.

The "top ten" components in each of the following categories account for more than:

[illegible]1% of all failures

[illegible]5% of all mission abort failures

[illegible]0% of all local corrective maintenance time to repair primary failures

31% of all local corrective maintenance manhours to repair primary failures

---

* Total Reliability - Probability of no failure in the specified time. This category applies to all classes of failure regardless of degree of severity and includes aborts, downs, minors, and malfunctions with no effect.

**Mission Reliability - Probability that a CH-54A will experience no mission aborting failure in a one-hour mission.

SUMMARY (Cont)

The 33 month cumulative reliability statistics show a slight change in reliability relative to the 30 month figures submitted in the last quarterly report as shown:

	30 Month Cumulative	33 Month Cumulative
CH-54A Total Reliability (1 hour)	.7850	.7865
CH-54A Mission Reliability (1 hour)	.9870	.9875

The distribution of failure rate among systems has changed slightly since the last report. Powerplant, rotors and blades, and transmission remain the top three failure rate systems. Lower MTBF's for instruments, hydraulics and communications now rank these three systems as the fourth, fifth and sixth major sources of unreliability. These six major areas account for 67% of the total aircraft failure rate. Powerplant, APP, hydraulics and transmission still rank as the top four major contributors of mission aborts and are responsible for 73% of the abort rate.

The "top ten" lists of components, R-1, R-2, and R-3, show slightly less impact on total aircraft reliability from top ten components.

Top ten components' contribution to aircraft unreliability have changed only slightly from that of the previous report:

	30 Month Cumulative	33 Month Cumulative
Based on failure rate	15%	15%
Based on number of failures	22%	22%
Based on abort rate	27%	25%

SUMMARY (cont)

New Components in top ten lists and the components they replace from the last quarterly are as follows:

Top Ten Category	New Components In Top Ten List	Components Deleted From Top Ten List
Number of Failure (List R-2)	Rotor Brake Package Assembly P/N 71428	MGB Oil Cooler V Belt P/N 3V600
Abort Rate (List R-3)	Cargo Hoist UP Pressure Tube P/N 6465-62051-061	Generator P/N 28B139-33A
Unscheduled Maintenance Manhours (List R-5)	Turbo shaft Engine Exhaust Duct P/N 571076	AFCS Servo Assembly P/N S6265-62551-10

SUMMARY (Cont)

Projections of component MTBR's (Mean Time Between Removals) based on 33 month cumulative data show slight deterioration from the 30 month cumulative figures submitted in the last report. Higher rates of failure and damage beyond local repair yield generally lower MTBR's. (Note that MTBR's continue to consider overhauls and scrappage arising from both primary failures and damage.)

COMPONENT	MTBR Based on 30 Month Cumulative Data	MTBR Based on 33 Month Cumulative Data
Main Rotor Head Assembly	3[illegible]2 hr	291 hr
APP Clutch Assembly	309 hr	311 hr
Tail Rotor Blade	374 hr	345 hr
Main Rotor Damper Assembly	391 hr	395 hr

DISCUSSION

Total Reliability

Figure A-1, the total reliability block diagram covering all major systems shows a 4.12 hour total mean time between failures and .7845 total aircraft reliability for a one-hour mission. The system code digits shown in the block diagram define system boundaries and the hardware included. They are defined in Appendix A2-1 of the ORE Handbook.

There were no changes in the total MTBF or the Reliability covering major systems from the last quarterly report.

	30 Month Cumulative	33 Month Cumulative
MTBF	4.12 hr	4.12 hr
Reliability (1 hour)	.785	.785

Figure A-1 shows powerplant, rotors and blades, transmission, instruments, hydraulics and communications as the major contributors to unreliability. Taken together these major systems account for 67.4% of all failures observed in the reporting period. Figures A-2 through A-7 show the breakout of total reliability among the individual system codes within these areas.

Powerplant - Figure A-2 highlights the engine and engine exhaust areas. Major problem items are tailpipes, flex shafts, fuel controls and exhaust ducts.

Rotors & Blades - Figure A-3 shows both tail and main rotor blades and the main rotor head to be major contributors to unreliability. Major problem items are tail rotor blade erosion, main rotor blade tip caps, and main rotor head droop restrainers.

Transmission - Figure A-4 highlights the rotor brake, main transmission and MGB oil cooler. Rotor brake pucks & support brackets are large contributors to unreliability. Main transmission failures are distributed among many component parts. Oil cooler V belts are the highest single contributors to MGB oil cooler unreliability.

Instruments - Figure A-5 highlights the instruments (from detector to indicator). The generator tachometer, servo network and the fuel flow transmitter are the major sources of unreliability.

Hydraulics - Figure A-6 highlights the cargo hoist and flight control hydraulics. Hoist up pressure tube, hoist pump, 1st stage hydraulic pump and the 2nd stage hydraulic manifold are the major sources of unreliability.

Communications - Figure A-7 highlights the ARC-54 VHF radio sets.

Corrective action procedures for increasing the reliability of various components and systems are discussed in detail in SER-64272-1 Monthly Progress Accomplishment Report.

Mission Reliability

Figure A-8, the total mission reliability block diagram, shows an 80.12 hour total mean time between failures for mission aborts and .9875 one-hour mission reliability.

These levels represent a 5% improvement in mission abort MTBF from the last quarterly report.

	30 Month Cumulative	33 Month Cumulative
MTBF, aborts	76.6 hr	80.2 hr
Mission Reliability (1 hour)	.9870	.9875

Figure A-8 shows powerplant, APP, hydraulics and transmission continue to be the major contributors to the mission abort rate. Taken together these four major systems account for 73.5% of all mission aborts observed in the reporting period. Figures A-9 through A-12 show the breakout of mission reliability among the individual system codes within these four areas.

Powerplant - Figure A-9 highlights the engine and engine hydraulic start. Fuel controls, engine start hydraulic lines, fuel pumps & flex shafts are important mission abort items.

APP - Figure A-10 highlights the APP itself. The APP fuel pressure switch and the APP fuel control are significant abort items.

Hydraulics - Figure A-11 shows cargo hoist hydraulics account for 55.8% of all hydraulic aborts. Pressure lines are a significant source of mission aborts.

Transmission - Figure A-12 shows the main transmission and the main gear box oil cooler to be major contributors among transmission systems. The oil cooler V belt is a large single source of aborts.

TOTAL RELIABILITY BLOCK DIAGRAM
MAJOR SYSTEMS

MTBF - 4.12 Hr Reliability (1 Hr) - .785

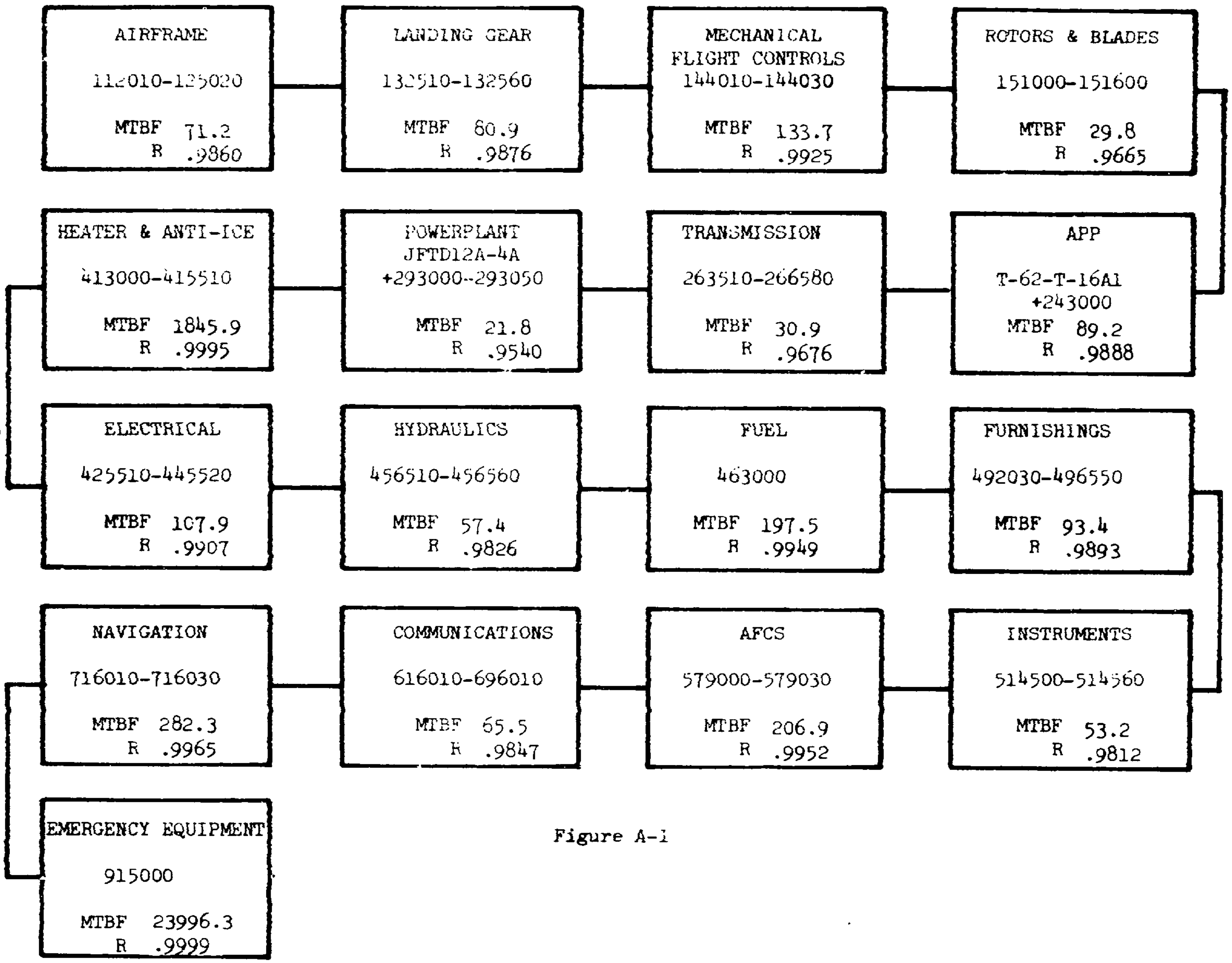


Figure A-1

TOTAL RELIABILITY BLOCK DIAGRAM - POWERPLANT SYSTEMS

MTBF - 21.8 Hr Reliability (1 Hr) - .9540

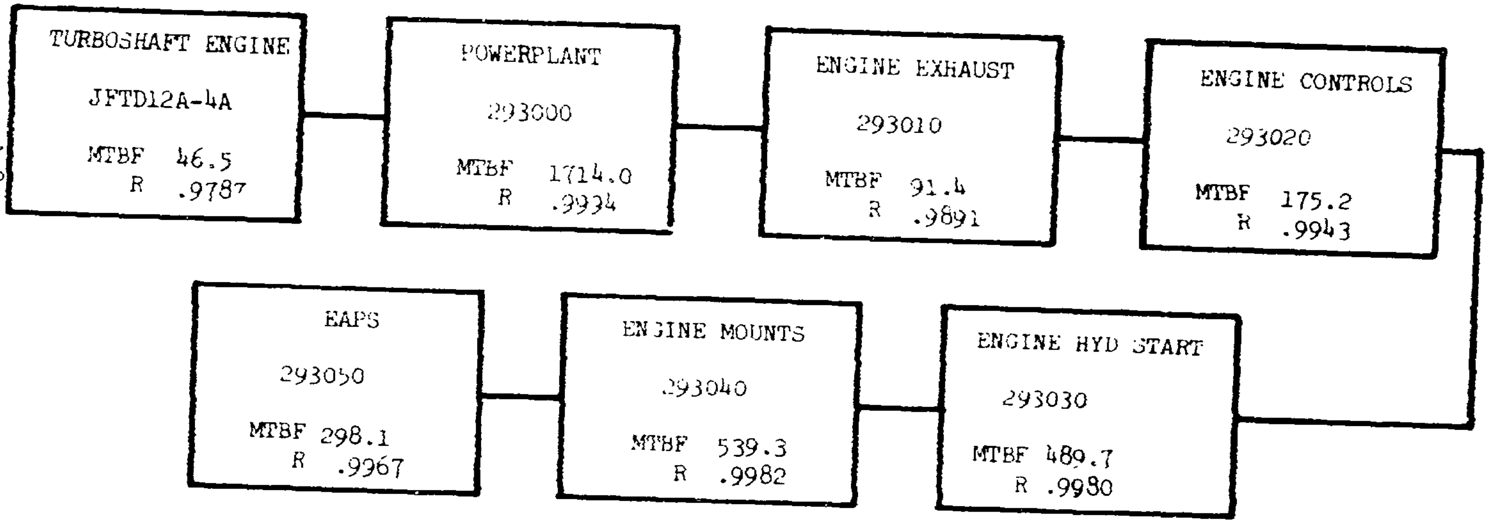


Figure A-2

TOTAL RELIABILITY BLOCK DIAGRAM - ROTOR AND BLADE SYSTEM

MTBF - [illegible] Reliability (1 Hr) - .9665

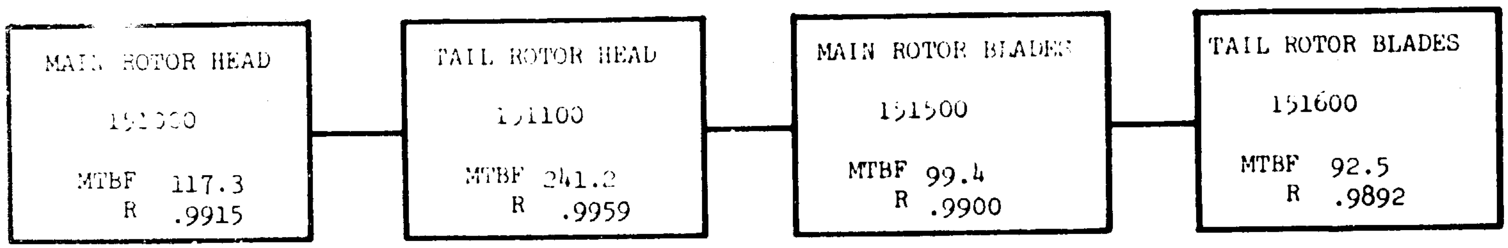


Figure A-3

TOTAL RELIABILITY BLOCK DIAGRAM - TRANSMISSION SYSTEMS

MTBF - 30.9 hr   Reliability (1 Hr) - .9676

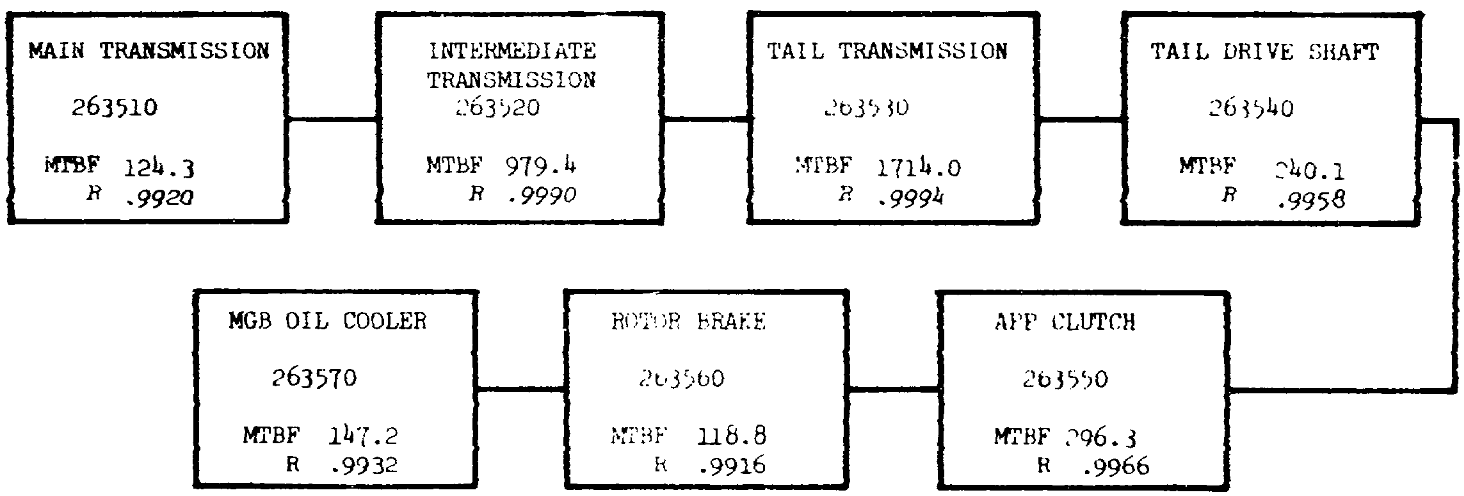


Figure A-4

TOTAL RELIABILITY BLOCK DIAGRAM - INSTRUMENTS SYSTEM

MTBF - 53.[illegible] Hr   Reliability (1 Hr) - .981[illegible]

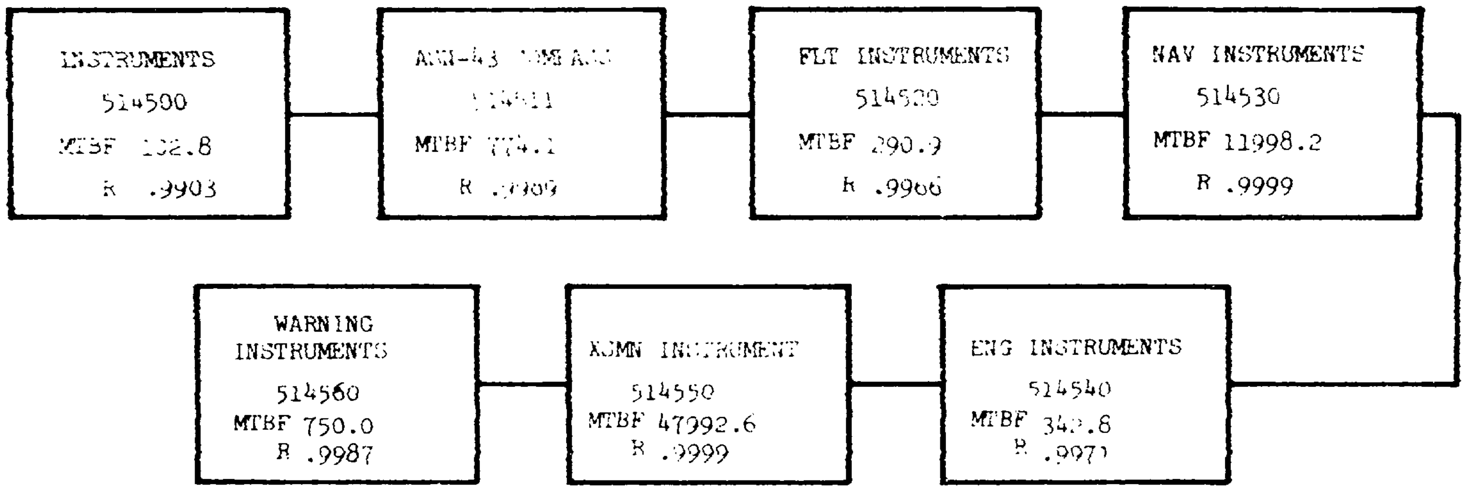


Figure A-5

TOTAL RELIABILITY BLOCK DIAGRAM - HYDRAULICS SYSTEM

MTBF - 57.4 Hr   Reliability (1 Hr) - .9826

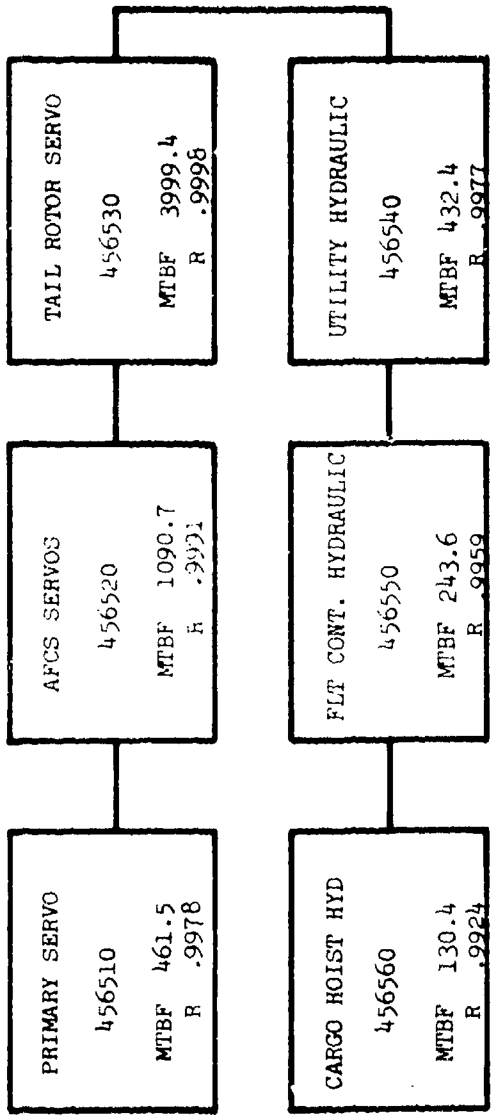


Figure A-6

TOTAL RELIABILITY BLOCK DIAGRAM - COMMUNICATION SYSTEM

MTBF - 65.5 Hr Reliability (1 Hr) - .9847

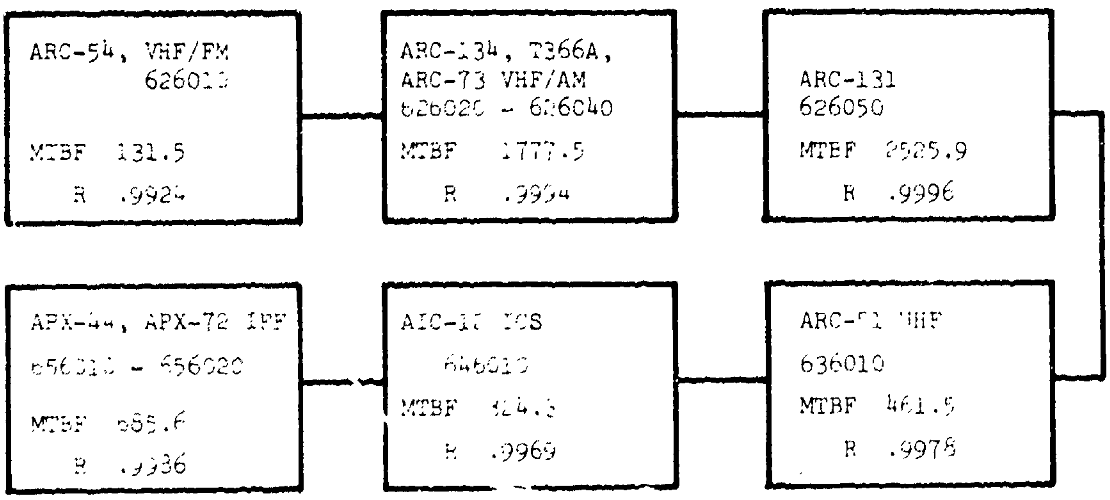
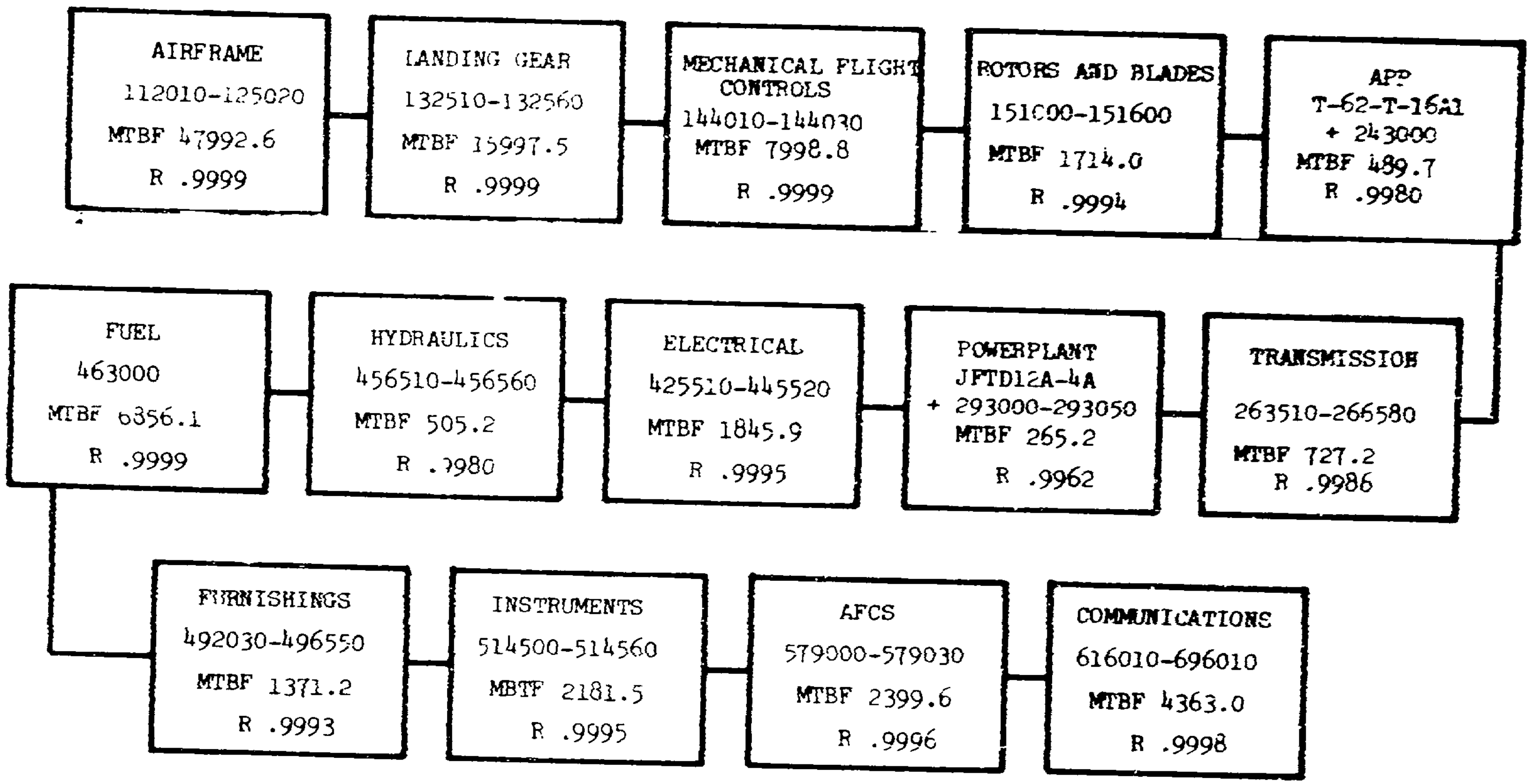


Figure A-7

MISSION RELIABILITY BLOCK DIAGRAM - MAJOR SYSTEMS

MTBF - 60.12 Reliability (1 Hr.) - .9875

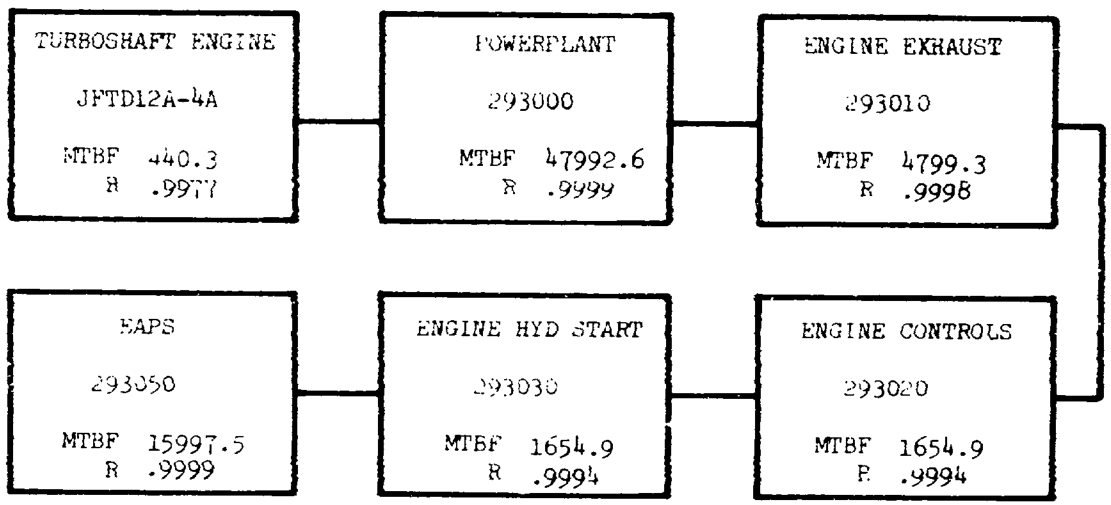


No Aborts Reported in Heater and Anti-Ice, Navigation, and Emergency Equipment.

Figure A-8

MISSION RELIABILITY BLOCK DIAGRAM - POWERPLANT SYSTEMS

MTBF - 265.2 Hr   Reliability (1 Hr) - .9962



No Aborts in Other Powerplant System Codes

Figure A-9

MISSION RELIABILITY BLOCK DIAGRAM - APP

MTBF - 489.7 Hr   Reliability (1 Hr) - .9980

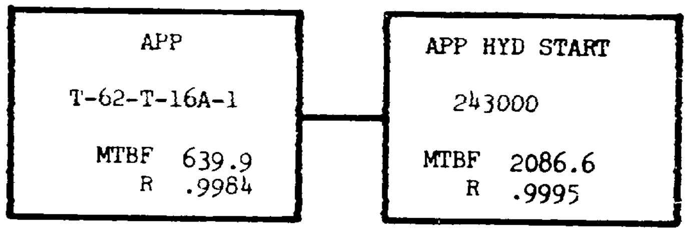
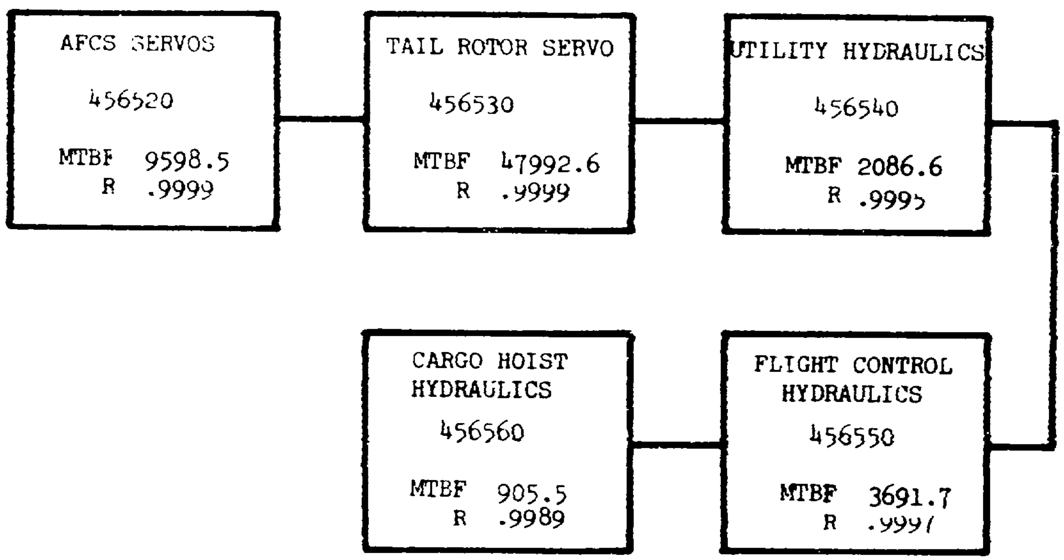


Figure A-10

MISSION RELIABILITY BLOCK DIAGRAM - HYDRAULIC SYSTEMS

MTBF - 505.2 Hr   Reliability (1 Hr) - .9980



No Aborts in Other Hydraulic System Codes

Figure A-11

MISSION RELIABILITY BLOCK DIAGRAM - TRANSMISSION SYSTEMS

MTBF - 727.2 Reliability (1 Hr) - .9986

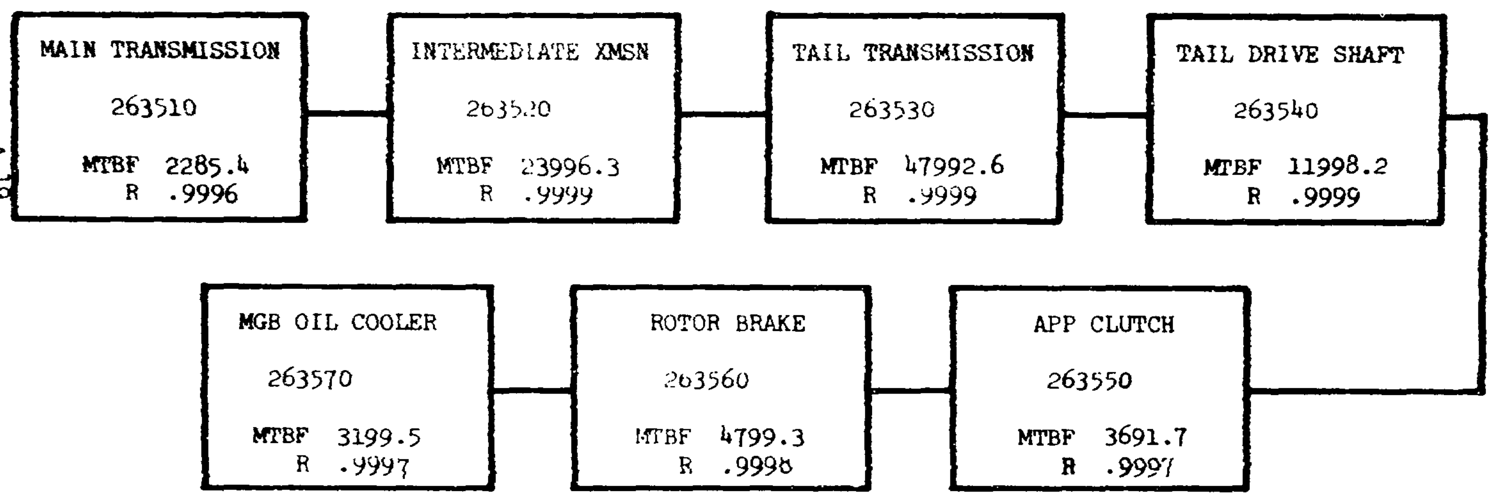


Figure A-12

Failure Rates and Reliabilities
(Data Item 08-010-1)

SYSTEMS

Table A-1, Section D of this report, provides the failure rates, reliabilities, and abort rates observed in this reporting period by system.

Thirty-three month cumulative behavior shows an increase in the reliability in a number of the systems relative to the 30 month cumulative behavior documented in the previous quarterly report.

Table A-1 shows a high concentration of primary failures in the following areas: powerplant, rotors and blades, transmission, instruments, hydraulics and communications. Taken together the systems in these major groupings account for an observed .163 failures per flight hour, 67% of the total .243 failures per flight hour for the overall aircraft.

The ten individual system codes with the highest observed failure rates are as follows:

System Code	Nomenclature	Failure Rate (Failures per hr)	Reliability (1 hour)
JFTD12A-4A	Turboshaft Engines	.021503	.9787
293010	Engine Exhaust	.010939	.9891
151600	Tail Rotor Blade	.010814	.9892
151500	Main Rotor Blade	.010064	.9900
514500	Instruments	.009731	.9903
151000	Main Rotor Head	.008522	.9915
263560	Rotor Brake	.008418	.9916
263510	Main Transmission	.008043	.9920
456560	Cargo Hoist Hydraulics	.007668	.9924
626010	ARC-54 VHF/FM	.007605	.9924

Taken together these ten system codes account for .103 failures per flight hour, 43% of the aircraft total.

Table A-1 shows a continued high concentration of mission abort failures in four areas: powerplant, APP, hydraulics, and transmission. Taken together the systems in these four major groupings account for an observed .0092 aborts per flight hour , 74% of the total .0125 aborts per flight hour for the overall aircraft.

The ten individual system codes with the highest observed abort rates are as follows:

System Code	Nomenclature	Failure Rate (Failures per hour)	Reliability (1 hour)
JFTD12A-4A	Turboshaft Engines	.002271	.9977
T-62-T-16A1	APP	.001563	.9984
456560	Cargo Hoist Hydraulics	.001104	.9989
495020	Cargo Winch	.000667	.9993
293020	Engine Controls	.000604	.9994
293030	Engine Hydraulic Start	.000604	.9994
243000	APP Hydraulic Start	.000479	.9995
263510	Main Transmission	.000438	.9996
514500	Instruments	.000396	.9996
425520	Generator	.000354	.9997
263570	MGB Oil Cooler	.000313	.9997

Taken together these ten system codes account for .0088 abort failures per flight hour, 71% of the aircraft total.

The MGB Oil Cooler System code is a new entry in this list replacing the Utility Hydraulic system code present in the previous 30 month cumulative list. The Engine Controls and Engine Hydraulic Start system codes have tied with the fifth highest abort rate.

Table A-1 shows a continued high concentration of maintenance manhours to repair primary failures in four areas: powerplant, transmission, rotors and blades, and hydraulics. Taken together the systems in these four major groupings account for an observed 25,290.8 maintenance manhours to repair primary failures, 67% of the total 37,662.2 manhours to repair all primary failures in all aircraft systems.

The ten individual system codes with the most maintenance manhours for primary failure repair are as follows:

System Code	Nomenclature	Maintenance Manhours to Repair Primary Failures
JFTD12A-4A	Turboshaft Engines	6359.2
151000	Main Rotor Head	3249.7
263510	Main Transmission	3139.5
456560	Cargo Hoist Hydraulics	149[illegible]
495020	Cargo Winch	1382.[illegible]
151500	Main Rotor Blade	1172.4
[illegible]	Fuel	1168.8
[illegible]	APU	10[illegible]
[illegible]	Tail Rotor Blade	10[illegible]
[illegible]	Engine Exhausts	104[illegible]

Taken together these ten system codes account for 21,179.2 maintenance manhours, 56% of the total required to repair all primary failures observed on the aircraft.

Table A-1 shows a continued high concentration of elapsed maintenance time to repair primary failures in five areas: powerplant, transmission, rotors and blades, hydraulics and airframe. Taken together the systems in these five major groupings account for an observed 15,526.3 elapsed hours for maintenance to repair primary failures, 69% of the total 22,530.9 hours to repair all primary failures in all aircraft systems.

The ten individual system codes with the most elapsed time for primary failure repair are as follows:

System Code	Nomenclature	Elapsed Time for Primary Failure Repair Active Maintenance
JFTD12A-4A	Turboshaft Engines	3158.9
263510	Main Transmission	1628.4
151000	Main Rotor Head	1310.5
456560	Cargo Hoist Hydraulics	949.9
151600	Tail Rotor Blade	732.2
*293010	Engine Exhaust	715.7
495020	Cargo Winch	711.8
[illegible]	Fuel	710.8
151500	Main Rotor Blade	663.3
T-62T-16A1	APP	650.9
263560	Rotor Brake	637.4

Taken together these system codes account for 11869.8 elapsed hours, 53% of the total required to repair all primary failures observed on the aircraft.

*The system codes present in the previous 30 month cumulative list have remained virtually the same, except the order has changed.

COMPONENTS

Table A-2, Section D of this report, provides the failure rates, reliabilities, and abort rates observed in this reporting period by component.

Within each system code Table A-2 arranges components alpha-numerically by Sikorsky and vendor part number of three levels of hardware, assembly, subassembly, and component. Corresponding federal stock numbers are also shown.

List R-1 in this section shows the ten assembly part numbers with the highest reported failure rates. Taken together they contribute 15% the total aircraft failure rate. There are no new additions or deletions to List R-1 for the last quarter.

R-1 printout entries correspond to the part numbers shown. In some cases Table A-2 reports additional failures of the same hardware against alternate part numbers so that the actual number of failures, component failure rates, and percentages are higher.

In general, the R-1 printout reflects the hardware level at which component replacement was performed on the aircraft. Major components such as the main transmission, for which Table A-1 shows a total .038043 failures per hour, do not appear since these failures are distributed among 101 separate lower level assemblies, each of which is repairable or replaceable on the aircraft.

R-1 entries for the engine exhaust tailpipe, tail rotor blade, and rotor brake support bracket identify the failed hardware meaningfully, in sufficient detail to show where reliability improvement at the component level can provide a relatively high yield in total failure rate reduction.

Other entries require additional explanation. Table A-2 in Section D shows that:

> Approximately 18% of all APP clutch malfunctions were traced to SB1125-1 bearings. An increase in failures in other subsystems has diluted the effect of the clutch problem relative to the total system.

Approximately 41% of all engine malfunctions diagnosed below the assembly level are attributable to exhaust ducts, fuel controls, fuel pumps, and shafts. Note that Table A-1 shows 1032 failures against the engine system code, more than four times the number shown in R-1. The remaining 784 are distributed among alternate part numbers and engine component parts accessible for on-aircraft repair or replacement.

Approximately one-quarter of all rotor brake malfunctions diagnosed below the assembly level are attributable to brake pucks. Puck failures together with rotor brake support bracket failures account for almost one half of all diagnosed failures. Note that Table A-1 shows 404 failures against the rotor brake system code, more than four times the number shown in R-1. The remaining 319 are distributed among alternate part numbers and rotor brake component parts accessible for on-aircraft repair or replacement.

Approximately 20% of all anti-collision light failures are attributable to MS25338-7079 incandescent light failures. Table A-1 shows 313 failures against the exterior light system code, more than twice the number shown in R-1. The remaining 172 are distributed among alternate part numbers and various components accessible for on-aircraft repair or replacement.

Approximately 20% of all MGB oil cooler malfunctions below the assembly level are attributable to the upper, lower and idler pulleys. Table A-1 shows 326 failures against the MGB oil cooler system code, more than twice the amount shown in R-1. The remaining 194 are distributed among various components accessible for on-aircraft repair or replacement.

A complete evaluation of ARC-54 failures is impossible because it requires additional data that is not currently available to ORE's. Meaningful identification of failure phenomenon requires electronic diagnosis within the receiver-transmitter to the component level. Current maintenance facilities at CH-54A operation sites do not permit such diagnosis. (The ARC-54 is being replaced by the ARC-131.)

The ARC-51 UHF receiver-transmitter is similar to the ARC-54 receiver-transmitter in that additional electronic diagnosis within these units is necessary for true component level reporting. Its failure rate is substantially lower and the effects of its failures upon mission reliability, maintenance manhours and elapsed maintenance downtime is substantially less. Depending upon the exact nature of the failure modes, failure rates may be reasonable and justified in light of the complexity inherent in this unit. Table A-1 shows an observed 461.3 hr MTBF for the ARC-51 system, - a level more than four times higher than the 100 hr specified by procurement specification MIL-R-22659B (AS).

In order to identify problem areas and possible future problems, additional top ten lists are included for the first time. These new lists are identified by the suffix A, and include only the data received during the past 3 month period. In this way we can better determine what are the current problem areas and if a potential fix has been made, whether or not it is effective.

List R-2 in this section shows the ten part numbers with the highest reported number of failures. This criterion spotlights cases where component failure rates below R-1's top ten combine with high quantities-per-aircraft to yield significant contributions to the total aircraft failure rate. Note that List R-2 accounts for approximately 21% of the total aircraft failure rate while List R-1 accounts for only 15%. Specifically List R-2 shows that:

6415-20209-041	Main Rotor Blade Tip Cap
6415-20201-041	Main Rotor Blade Assembly
65160-00001-045	Tail Rotor Blade Assembly
6435-60028-010	Tail Drive Shaft Support Assembly
71428	Rotor Brake Package Assembly

fall below List R-1's top ten on the basis of failure rates but contribute substantially to aircraft unreliability.

The Rotor Brake Package P/N 71428 is a new entry in R-2 replacing the MGB Oil Cooler V Belt P/N 3V600 present in the previous 30-month cumulative list.

List R-2A shows those items with the highest number of failures which have occurred during the past quarter. A review of the Monthly Accomplishement Report SER 64276-1, will describe the corrective action taken.

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TOP TE - FAILURE RATE

List R-1 Rev J

FROM. 680101 TO 700930

LOCATION - ALL

FLIGHT TIME - 47992.6

AIRCRAFT SERIAL NO. RANGE - ALL

COMPONENT P/N	NOMENCLATURE	NO. OF FAILURES	COMP. FAILURE RATE	QTY PER A/C	TOTAL FAILURE RATE	PERCENT OF A/C FAIL. RATE
626010 RT-348/ARC-54	ARC-54 VHF REC-TRANS.	312	.006501	1	.006501	2.7
293010 6430-80601-082	ENGINE EXHAUST TAIL PIPE ASSY	431	.004490	2	.008981	3.7
263550 56137-91000-015	APP CLUTCH APP CLUTCH	140	.002917	1	.002917	1.2
JFTD12A-4A 572200	TURBO-SHAFT ENG ENGINE	248	.002584	2	.005167	2.1
636010 RT-742/ARC-51BX	ARC-51 UHF REC-TRANS	86	.001792	1	.001792	.7
263560 6465-20016-012	ROTOR BRAKE SPT ROTOR BRAKE	85	.001771	1	.001771	.7
579010 6490-60105-101	AFCS AMPLIFIER AMPLIFIER CONTR	72	.001500	1	.001500	.6
445510 MS25277-2	EXTERIOR LIGHTS LIGHT ANTI COLL	141	.001469	2	.002938	1.2
579030 6490-60131-011	REMOTE STICK REMOTE STICK	67	.001396	1	.001396	.6
263570 3V600	MGB OIL COOLER V BELT	132	.001375	2	.002750	1.1

TOP TEN - FAILURE RATE   List R-1A Rev J   FROM: 700701 TO 700930   LOCATION - ALL

FLIGHT TIME - 3001.2   AIRCRAFT SERIAL NO. RANGE - ALL

COMPONENT P/N	NOMENCLATURE	NO. OF FAILURES	COMP. FAILURE RATE	QTY PER A/C	TOTAL FAILURE RATE	PERCENT OF A/C FAIL. RATE
*****************	*****************	********	*******	***	*******	**********
293010 6430-80601-082	ENGINE EXHAUST TAIL PIPE ASSY	30	.004998	2	.009996	4.5
628010 RT-348/ARC-54	ARC-54 VHF REC-TRANS.	13	.004332	1	.004332	1.9
263550 S6137-91000-015	APP CLUTCH APP CLUTCH	12	.003998	1	.003998	1.8
579010 6490-60105-101	AFCS AMPLIFIER AMPLIFIER CONTR	8	.002666	1	.002665	1.2
263510 6435-20400-047	MAIN TRANSMISION MAIN GEAR BOX	5	.001666	1	.001666	.7
626050 RT-823/ARC-131	ARC-131 REC-TRANS	5	.001666	1	.001666	.7
293020 6430-80326-101	ENGINE CONTROLS ACTUATOR SPEED	9	.001499	2	.002999	1.3
JFTD12A-4A 571078	TURBO-SHAFT ENG FUEL CONTROL	9	.001499	2	.002999	1.3
579030 6490-60131-011	REMOTE STICK REMOTE STICK	4	.001333	1	.001333	.6
495010 XW20403H90-20	WINDSHIELD WIPER WIPER ASSY	8	.001333	2	.002666	1.2

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TOP TEN - NUMBER OF FAILURES   FROM: 680101 TO 700930   LOCATION - ALL

List R-2 Rev J

FLIGHT TIME - 47992.6   AIRCRAFT SERIAL NO. RANGE - ALL

COMPONENT P/N	NOMENCLATURE	NO. OF FAILURES	COMP. FAILURE RATE	QTY PER A/C	TOTAL FAILURE RATE	PERCENT OF TOTAL NO. FAILURES
151600 65160-00001-045	TAIL ROTOR BLADE BLADE ASSY T/R	477	.000000	-0	.000000	4.1
293010 6430-80601-082	ENGINE EXHAUST TAIL PIPE ASSY	431	.004490	2	.008981	3.7
626010 RT-348/ARC-54	ARC-54 VHF REC-TRANS.	312	.006501	1	.006501	2.7
JFTD12A-4A 572200	TURBO-SHAFT ENG ENGINE	248	.002584	2	.005167	2.1
151500 6415-20209-041	MAIN ROTOR BLADE CAP TIP	225	.000781	6	.004688	1.9
151500 6415-20201-041	MAIN ROTOR BLADE BLADE ASSYS.M/R	212	.000736	6	.004417	1.8
263540 6435-60028-010	TAIL DRIVE SHAFT SUPPORT ASSY	149	.000621	5	.003105	1.3
445510 MS25277-2	EXTERIOR LIGHTS LIGHT ANTI COLL	141	.001469	2	.002938	1.2
263550 56137-91000-015	APP CLUTCH APP CLUTCH	140	.002917	1	.002917	1.2
263560 71428	ROTOR BRAKE BRAKEPACKAGEASSY	134	.000000	-0	.000000	1.2

TOP TEN - NUMBER OF FAILURES Lift R-2A Rev 3 FROM: 700701 TO 700930 LOCATION - ALL

FLIGHT TIME = 3001.2 AIRCRAFT SERIAL NO. RANGE = ALL

COMPONENT P/N	NOMENCLATURE	NO. OF FAILURES	COMP. FAILURE RATE	QTY PER A/C	TOTAL FAILURE RATE	PERCENT OF TOTAL NO. FAILURES
293016 6430-60601-602	ENGINE EXHAUST TAIL PIPE ASSY	30	.004998	2	.009996	4.5
263540 6435-60828-010	TAIL DRIVE SHAFT SUPPORT ASSY	18	.001200	5	.005998	2.7
151500 6415-20201-041	MAIN ROTOR BLADE BLADE ASSY MR	17	.000944	6	.005664	2.5
626010 RT-348/ARC-34	ARC-34 VHF REC-TRANS.	13	.004332	1	.004332	1.9
263030 S6137-91000-015	APP CLUTCH APP CLUTCH	12	.003998	1	.003998	1.8
263000 71428	ROTOR BRAKE BRAKEPACKAGEASSY	12	.000000	-0	.000000	1.8
151600 65161-00001-041	TAIL ROTOR BLADE TAIL ROTOR BLADE	12	.001000	4	.003998	1.8
151600 65160-00001-045	TAIL ROTOR BLADE BLADE ASSY T/R	12	.000000	-0	.000000	1.8
151500 6415-20209-041	MAIN ROTOR BLADE CAP TIP	10	.000555	6	.003332	1.5
293020 6430-80326-101	ENGINE CONTROLS ACTUATOR SPEED	9	.001499	2	.002999	1.3

List R-3 in this section shows the ten component part numbers with the highest reported mission abort rates. Taken together they contribute 25% of the total mission abort rate.

The Cargo Hoist Up Pressure tube, P/N 6465-62051-061, is a new entry in R-3 replacing the Generator, P/N 28B139-33A, present in the previous 30 month cumulative list.

R-3 printout entries correspond to the part numbers shown. In some cases Table A-2 reports additional aborts of the same hardware against alternate part numbers so that the actual number of aborts, component abort rates, and percentages are higher.

R-3 shows 22% of the total mission abort rate concentrated in engine, APP, powerplant and engine control components necessary for the engine start cycle.

Virtually all R-3 entries are well defined. Components are identified meaningfully - in sufficient detail to show where reliability improvement at the component level can provide a reduction in the total abort rate. List R-3A shows those components with the highest report mission abort rates during the last quarter.

List R-4 shows the ten component part numbers with the most reported elapsed active maintenance time required to repair primary failures. R-4 highlights cases where the combined effects of high failure rates and lengthy times to repair have an overall large impact on the total maintenance required to support the aircraft. Taken together these ten components are responsible for approximately 26% of the total time required to repair all observed primary failures.

There has been virtually no change in List R-4 from the previous 30 month cumulative list.

List R-4A shows those components with the most reported elapsed active maintenance time required to repair primary failures during the last quarter.

TOP TEN - ABORT RATE FROM: 680101 TO 700930 LOCATION - ALL

LIST R-3 REV J

FLIGHT TIME - 47992.6 AIRCRAFT SERIAL NO. RANGE - ALL

COMPONENT P/N	NOMENCLATURE	NO. OF ABORTS	COMP. ABORT RATE	QTY PER A/C	TOTAL ABORT RATE	PERCENT OF A/C ABORT RATE
293030 55*5C3E214000	ENGINE HYD START HOSE ASSY PRESS	17	.000354	1	.000354	2.8
JFTD12A-4A 571078	TURBO-SHAFT ENG FUEL CONTROL	32	.000333	2	.000667	5.3
T-62-T-16A1 44936-0	APP FUEL CONTROL APP	14	.000292	1	.000292	2.3
T-62-T-16A1 37697-0	APP SW FUEL PRESS	13	.000271	1	.000271	2.2
T-62-T-16A1 37747-100	APP APP	12	.000250	1	.000250	2.0
263550 58137-91000-015	APP CLUTCH APP CLUTCH	11	.000229	1	.000229	1.8
JFTD12A-4A 572200	TURBO-SHAFT ENG ENGINE	21	.000219	2	.000438	3.5
243000 53WK04001	APP HYD START STARTER APP	10	.000208	1	.000208	1.7
495020 6450-62100-102	CARGO WINCH RELEASE CARGO	10	.000208	1	.000208	1.7
456560 6465-62051-061	CARGO HOIST HYD. TUBE P HOIST UP	9	.000188	1	.000188	1.5

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TOP TEN - ABORT RATE   List R-2A Rev 3   FROM: 700701 TO 700930   LOCATION - ALL

FLIGHT TIME - 3001.2   AIRCRAFT SERIAL NO. RANGE - ALL

COMPONENT P/N	NOMENCLATURE	NO. OF ABORTS	COMP. ABORT RATE	QTY PER A/C	TOTAL ABORT RATE	PERCENT OF A/C ABORT RATE
JFTD12A-4A 571078	TURBO-SHAFT ENG FUEL CONTROL	3	.000500	2	.001000	10.7
151000 S1505-2469	MAIN ROTOR HEAD FLUID TANK COVER	1	.000333	1	.000333	3.6
263510 35016C	MAIN TRANSMISION SEAL	1	.000333	1	.000333	3.6
263510 6435-20140-100	MAIN TRANSMISION COUPLING SPLINED	1	.000333	1	.000333	3.6
263510 6435-20400-047	MAIN TRANSMISION MAIN GEAR BOX	1	.000333	1	.000333	3.6
293020 6430-60326-101	ENGINE CONTROLS ACTUATOR SPEED	2	.000333	2	.000666	7.1
456560 6465-62051-061	CARGO HOIST HYD. TUBE P HOIST UP	1	.000333	1	.000333	3.6
495020 PT06SP22-21P	CARGO WINCH CONNECTOR PLUG	1	.000333	1	.000333	3.6
495020 6450-62352-104	CARGO WINCH DECOUPLER	1	.000333	1	.000333	3.6
495500 6490-60220-011	FIRE DETECTION PANEL ASSY, FIRE	1	.000333	1	.000333	3.6

TOP TEN - ACTIVE ELAPSED MAINTENANCE TIME FROM: 680101 TO 700930 LOCATION - ALL

FLIGHT TIME - 47992.6 AIRCRAFT SERIAL NO. RANGE - ALL

List R-4 Rev J

COMPONENT P/N	NOMENCLATURE	ACTIVE EMT	PERCENT OF A/C TOTAL
JFTD12A-4A 572200	TURBO-SHAFT ENG ENGINE	1352.	6.0
263510 6435-20400-047	MAIN TRANSMISION MAIN GEAR BOX	754.	3.3
JFTD12A-4A 571078	TURBO-SHAFT ENG FUEL CONTROL	703.	3.1
151600 65160-00001-045	TAIL ROTOR BLADE BLADE ASSY T/R	683.	3.0
293010 6430-80601-082	ENGINE EXHAUST TAIL PIPE ASSY	646.	2.9
626010 RT-348/ARC-54	ARC-54 VHF REC-TRANS.	424.	1.9
263540 6435-60028-010	TAIL DRIVE SHAFT SUPPORT ASSY	370.	1.6
263550 56137-91080-015	APP CLUTCH APP CLUTCH	329.	1.5
151500 6415-20201-041	MAIN ROTOR BLADE BLADE ASSYS,M/R	308.	1.4
151500 6415-20209-041	MAIN ROTOR BLADE CAP TIP	296.	1.3

TOP TEN - ACTIVE ELAPSED MAINTENANCE TIME FROM: 700701 TO 700930 LOCATION - ALL

FLIGHT TIME = 3001.2 AIRCRAFT SERIAL NO. RANGE = ALL

LIST R-4A REV J

COMPONENT P/N	NOMENCLATURE	ACTIVE EMT	PERCENT OF A/C TOTAL
263510 6435-20400-047	MAIN TRANSMISION MAIN GEAR BOX	102.	8.1
263540 6435-60028-010	TAIL DRIVE SHAFT SUPPORT ASSY	68.	5.3
JFTD12A-4A 572200	TURBO-SHAFT ENG ENGINE	67.	5.3
JFTD12A-4A 571078	TURBO-SHAFT ENG FUEL CONTROL	59.	4.7
293010 6430-80601-C82	ENGINE EXHAUST TAIL PIPE ASSY	45.	3.6
263550 56137-91000-0'5	APP CLUTCH APP CLUTCH	29.	2.3
463000 6430-62094-013	FUEL CELL FUEL	24.	1.9
456510 51565-20421-10	PRIMARY SERVO SERVO M/R	20.	1.6
151500 6415-20201-041	MAIN ROTOR BLADE BLADE ASSY MR	19.	1.5
JFTD12A-4A 571076	TURBO-SHAFT ENG DUCT EXH TURBINE	19.	1.5

List R-5 shows the ten component part numbers with the most reported maintenance manhours required to repair primary failures. R-5 highlights cases where the combined effects of high failure rates, lengthy times to repair, and required large complements of maintenance personnel have an overall large impact on the total aircraft maintenance burden. Taken together these ten components are responsible for 31% of the total maintenance manhour work load required to repair all primary failures.

The Turbo Shaft Engine Exhaust Duct, P/N 571076, is a new entry in R-5 replacing the AFCS Servo Assembly, P/N S6265-62551-10 present in the previous 30 month cumulative list.

R-5 printout entries correspond to the part numbers shown. In some cases Table A-2 shows additional maintenance required to repair primary failures of the same hardware against alternate part numbers so that the actual maintenance times and percentages are higher.

List R-5A shows those components with the most reported maintenance manhours required to repair primary failures, during the last quarter.

TOP TEN - UNSCHEDULED MAINTENANCE MANHOURS FROM: 680101 TO 700930 LOCATION - ALL

FLIGHT TIME - 47992.6 AIRCRAFT SERIAL NO. RANGE - ALL

List R-5 Rev J

COMPONENT P/N	NOMENCLATURE	UNSCHED. MANHOURS	PERCENT OF A/C TOTAL
JFTD12A-4A 572200	TURBO-SHAFT ENG ENGINE	3175.	8.4
263510 6435-20400-047	MAIN TRANSMISION MAIN GEAR BOX	1854.	4.9
JFTD12A-4A 571078	TURBO-SHAFT ENG FUEL CONTROL	1466.	3.9
151600 65160-00001-045	TAIL ROTOR BLADE BLADE ASSY T/R	1005.	2.7
293010 6430-80601-082	ENGINE EXHAUST TAIL PIPE ASSY	954.	2.5
151000 6410-20004-023	MAIN ROTOR HEAD HEAD ASSY MR	746.	2.0
263540 6435-60028-010	TAIL DRIVE SHAFT SUPPORT ASSY	724.	1.9
151500 6415-20201-041	MAIN ROTOR BLADE BLADE ASSYS,M/R	659.	1.8
151000 6410-20004-015	MAIN ROTOR HEAD HEAD ASSY MR	657.	1.7
JFTD12A-4A 571076	TURBO-SHAFT ENG DUCT EXH TURBINE	551.	1.5

TOP TEN - UNSCHEDULED MAINTENANCE MANHOURS   FROM: 700701 TO 700930   LOCATION - ALL

FLIGHT TIME - 3001.2   AIRCRAFT SERIAL NO. RANGE - ALL

LIST R-5A REV J

COMPONENT P/N	NOMENCLATURE	UNSCHED. MANHOURS	PERCENT OF A/C TOTAL
263510 6435-20400-047	MAIN TRANSMISSION MAIN GEAR BOX	266.	11.9
JFTD12A-4A 572268	TURBO-SHAFT ENG ENGINE	162.	7.2
263540 6435-60028-010	TAIL DRIVE SHAFT SUPPORT ASSY	135.	6.0
JFTD12A-4A 571078	TURBO-SHAFT ENG FUEL CONTROL	105.	4.7
293010 6430-80601-082	ENGINE EXHAUST TAIL PIPE ASSY	60.	2.7
191500 6415-28281-041	MAIN ROTOR BLADE BLADE ASSY MR	57.	2.5
132530 6425-50102-014F	MAIN LANDING GEAR STRUT ASSY	55.	2.4
263510 6435-20400-027	MAIN TRANSMISSION MAIN GEAR BOX	51.	2.3
465000 6430-62094-013	FUEL CELL FUEL	51.	2.3
JFTD12A-4A 571076	TURBO-SHAFT ENG DUCT EXH TURBINE	52.	2.3

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Mean Time Between Removals (MTBR)

(Data Item 08-010-2)

The component control table, Table A-3 in Section D, provides MTBR's for all on-condition and TBO components listed in TB 55-1500-307-25, October 1968.

For each component, the analysis combines the reported number of unscheduled removals beyond local repair, the accumulated component flight time, and the TBO or retirement interval currently in effect to project long term estimates of mean time between removals.

Table A-3 continues to show the effect of secondary failures and damage on the MTBR of relatively few components.

Component	Effect of Secondary Failures and Damage on MTBR Secondary Failure and Damage Rate / Primary Failure Rate
Main Rotor Blade	1.89
Cargo Hoist Cable Assembly	1.19
Main Rotor Head	1.08
Engine Assembly, Turbo	.72
Cargo Hook	.26
Main Gear Box	.24

Eleven other component MTBR's are slightly affected by secondary failure and damage. The effect on these components is less than 10% of the primary failure rate.

Relative to the last quarterly report Table A-3 shows 18 components with lower MTBR's and 8 with higher MTBR's. As outlined above, except for relatively few components the effect of adding secondary failure and damage removals is slight. In general, lower MTBR's are attributable to higher rates of primary failure requiring overhaul or scrappage.

Table A-3 identifies the following as the lowest projected MTBR items:

Component	MTBR Based on 30 Month Cumulative Data	MTBR Based on 33 Month Cumulative Data
Main Rotor Head Assembly	322 hr.	291 hr.
APP Clutch Assembly	309 hr.	311 hr.
Tail Rotor Blade	374 hr.	345 hr.
Main Rotor Damper Assembly	391 hr.	395 hr.

MAINTAINABILITY

ANALYSIS

MAINTAINABILITY

SUMMARY

This section provides detail reporting of the following program requirements:

- Average Active Maintenance Downtime/Flight Hour
- On-Aircraft MTTR (Mean Time to Repair) for Components, Subsystems, and System
- Average Manhours/Active Maintenance Downhour
- Active Maintenance Manhours/Flight Hour

The data inputs are compiled and tabulated using electronic data processing with programming techniques to provide detailed runs for the above items. The computer programs for maintenance, utilization and availability data are equipped to process data on ten million total cumulative elapsed hours and manhours and 100,000 corrective or preventive maintenence actions. These programs provide averages and rates directly applicable to the contract data items.

Based on analysis of the 33 months accumulated data from all locations, the resultant values of the above characteristics are summarized as follows along with the net change from that of the previous quarterly report:

	CHARACTERISTICS	Value	Trend
1.	Average Active Maintenance Downtime/Flight Hour	2.3	+0.1
2.	Elapsed Mean Time to Repair (Corrective, elapsed)	1.9	±0.0
3.	Average Manhours/Downhour	2.8	±0.0
4.	Active Maintenance Manhours/Flight Hour	6.4	±0.0

Organization codes cited on the Tables in Section D are identified in Amendment 1 of the ORE Handbook.

S-45

Average Active Maintenance Downtime per Flight Hour
(Data Item 08-010-4)

The presentation of this data item has been expanded to display (1) the current calendar quarter and (2) the total cumulative data. The analysis is further subdivided to permit comparison of maintenance activity characteristics between USAREUR, RVN and CONUS operations for the above calendar periods.

Based on all contract data inputs for 33 calendar months, the cumulative average active maintenance downtime per flight hour (for corrective and preventive maintenance actions) is as follows:

	CONUS	RVN	USAREUR	ALL LOCATIONS
Corrective Maintenance DH/FH	0.7	0.5	0.5	0.5
Preventive Maintenance DH/FH	1.6	1.8	2.0	1.8
Total Maintenance DH/FH	2.3	2.3	2.5	2.3

The complete analysis is presented in Table B-1 of Section D.

On-Aircraft Component and System Mean Time to Repair (MTTR)
(Data Item 08-010-5)

The MTTR for corrective maintenance actions, as defined in the ORE Handbook, is presented in Tables B-1 and B-2 of Section D. The analysis is presented by total aircraft and major subsystem for (1) the current calendar quarter and (2) the total cumulative data. The analysis is further subdivided to permit repair time comparisons between USAREUR, RVN and CONUS operations for the above calendar periods. The analysis for component MTTR is an extensive data run and therefore is presented only for the cumulative 33 month period at all operating locations combined.

Based on corrective action data inputs from all locations for the 33 months of the program, the cumulative average active elapsed repair time for the total CH-54A system is as follows:

CONUS	RVN	USAREUR	ALL LOCATIONS
1.7 hrs	2.0 hrs	2.0 hrs	1.9 hrs

Refer to Tables B-2 and B-3 of Section D for major subsystem breakout and component analysis data run. Also, the $MTTR_e$ and $MTTR_m$ for the major subsystems is graphically displayed in Figure B-1, page B-5.

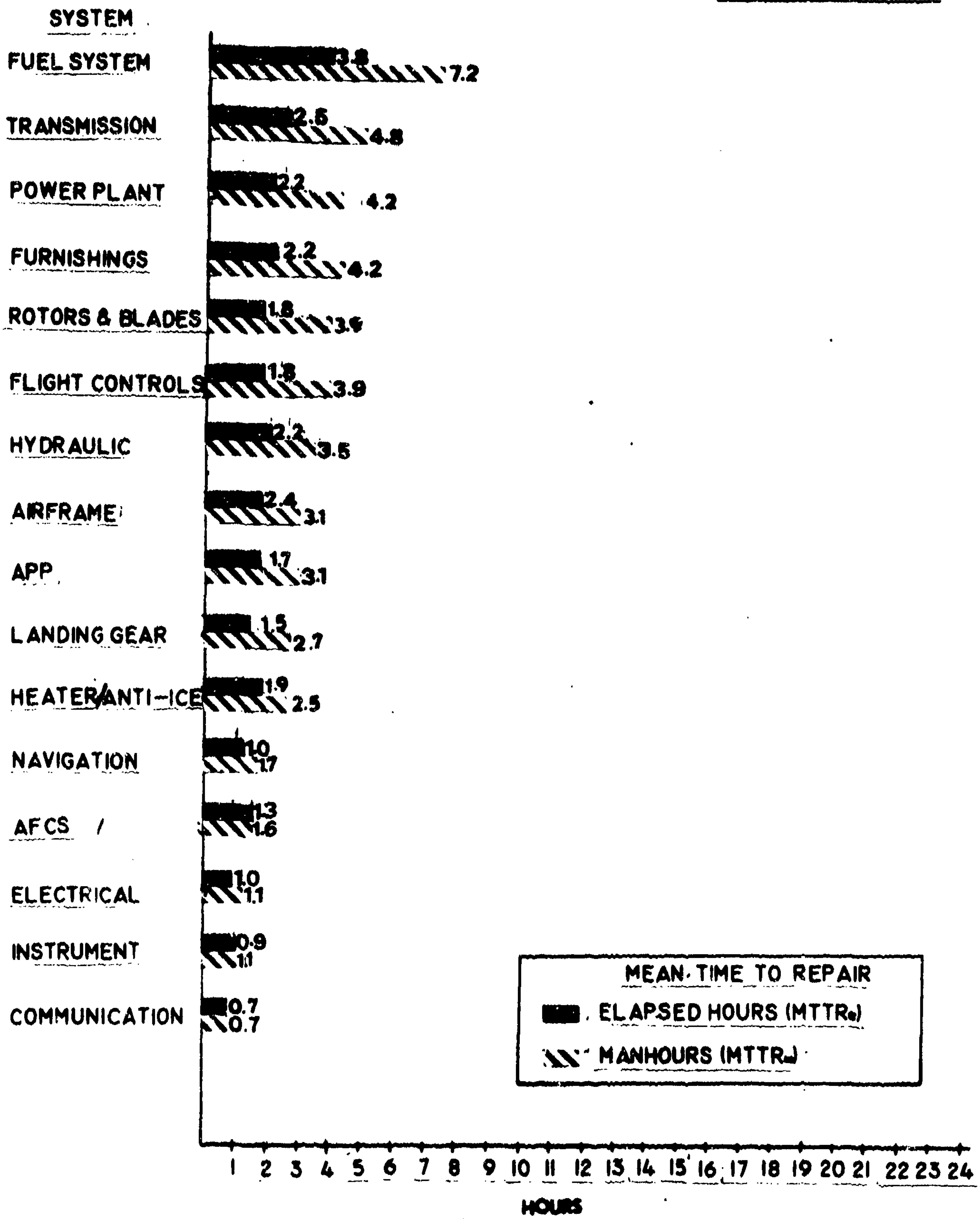

FIGURE B-1: MEAN CORRECTIVE MAINTENANCE TIME – ALL LOCATIONS –33 MONTH AVERAGE

C-48

Average Manhours per Active Maintenance Downhour
(Data Item 08-010-6)

The average active manhours per active maintenance downhour is presented for the total CH-54A system in Tables B-1 and B-2, and for subsystems and components in Table B-3, Section D of this report.

The analysis is presented for (1) the current calendar quarter and (2) the total cumulative data. The analysis is further subdivided to permit comparison between USAREUR, RVN and CONUS operations for the above calendar periods.

Active maintenance manhours per flight hour are also of prime interest in evaluating the weapon system characteristics. This value is cited along with active manhours per downhour in the following summation of the 33 months accumulated data.

	CONUS		RVN		USAREUR		All Locations	
	MH/DH	MH/FH	MH/DH	MH/FH	MH/DH	MH/FH	MH/DH	MH/FH
Corrective Maintenance	1.2	1.15	1.9	0.91	1.4	0.72	1.8	0.95
Preventive Maintenance	3.4	5.36	3.0	5.46	2.4	4.80	3.0	5.41
Combined	2.9	6.51	2.8	6.37	2.2	5.52	2.8	6.36
Spares Cannibalization		0.13		0.07		0.20		0.09
Total		6.64		6.44		5.72		6.45

Data input totals for the above calculated values are shown in Tables B-1 and B-2 of Section D.

A further analysis by maintenance levels of the above active MH/FH for the 33 months accumulated data, excluding cannibalizations, is as follows:

	CONUS		RVN		USAREUR		All Locations	
Org. Level - Corrective MH/FH	0.78		0.68		0.25		0.68	
Org. Level - Preventive MH/FH	5.32		5.28		4.76		5.27	
Sub-total		6.10		5.96		5.01		5.95
Direct Support - Corrective MH/FH	0.37		0.23		0.47		0.27	
Direct Support - Preventive MH/FH	0.04		0.18		0.04		0.14	
Sub-total		0.41		0.41		0.51		0.41
Total		6.51		6.37		5.52		6.36

AVAILABILITY AND UTILIZATION ANALYSIS

Availability and Utilization

SUMMARY

The data submitted within this section includes the following categories:

- Inherent Availability
- Achieved Availability
- Operational Availability
- Mean Configuration Change Time
- Average Flight Hours
- Average Flight Duration
- Average Turnaround Time

Each additional recurring quarterly report will be provided with an increasingly larger sample of accumulated data on which to base these tabulations and averages.

Included in this report are tables showing the types of missions flown as coded in the field and identified in the ORME Handbook, Appendix 1-5. These tables identified as Aircraft Utilization - Flight Time and Mission Type (Tables C-18 thru C-34) are located in the Appendix Section for reference.

Flight data as shown in D-B and D-C Tables reflects only that flying time on the aircraft under cognizance of the Operations Reliability Engineer in the field and not the total flying hours of all CH-54A aircraft for the program period.

Based on analysis of 33 months accumulated data, resultant values of the above characteristics are summarized as follows along with the net change from that of the previous quarterly report.

CHARACTERISTICS	Value	Trend
Inherent Availability	57.2	-10.7%
Achieved Availability	89.2%	+0.3%
Operational Availability	54.3%	+0.2%
Mean Configuration Change Time (Elapsed Hours)	0.4	±0.0
Average Flight Hours/Quarter/Aircraft	69.3	-1.0
Average Flight Duration-Hours	2.6	+0.1
Average Turnaround Time (Elapsed Hours)	0.2	+0.0

The operational and inherent availability is graphically displayed in Figures C-1 and C-2, pages C-9 and C-10, respectively.

Inherent Availability
(Data Item 08-010-7)

The inherent availability, as defined in the ORE Handbook, is a measurement of availability in terms of inherent reliability (MTBF) and average repair times for those malfunctions used to calculate that reliability. It is expressed by:

$$A_i = \frac{MTBF}{MTBF + MTTR_e}$$

The inherent availability is shown below for the total 33 month cumulative data:

	Cumulative Data 33 Months All Locations	3rd Qtr 1970
Flight Time, Hours*	47,994	3,001
Quantity of Primary Failures**	11,640	667
MTBF, hours	4.12	4.49
Downtime for Failures**, Hours	37,662	2,247
$MTTR_e$, Hours +	3.23	3.36
Inherent Availability	56.1%	57.2%

The cumulative (33 months) inherent availability has dropped 11.7% owing to a significant increase in $MTTR_e$. The 3rd quarter inherent availability has also dropped (12.2%) ending an upward trend which was apparent since the 4th quarter '69. The 3rd quarter 70 $MTTR_e$ has also increased significantly as has the failure rate and downtime relative to quantity of primary failures. The inherent availability trend by calendar quarters is shown in Figure C-2, page C-10.

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* From Table B-1

** From Table A-1, excludes corrective actions not classed as primary failures. Total corrective actions cited in Tables B-1 and B-2.

\+ Total primary failure active elapsed maintenance time/total primary failures.

Achieved Availability

Achieved Availability (Aa) as defined in MIL-STD-778 differs from Inherent Availability (Ai) in that Ai deals only with equipment operating time, primary failures and the associated failure repair time, whereas, Aa includes operating time, ready time, failure repair and preventive inspection time. Therefore, one explanation of Aa is to define it as a more inclusive version of Ai, with no new factors introduced which are not directly a function of the designed reliability and/or the pre-planned maintenance cycles. Achieved Availability is expressed as:

$$Aa = \frac{MTBM}{MTBM+\overline{M}}$$

where:

MTBM = Mean-Time-Between-Maintenance consisting of (for a given calendar interval) the sum of the operating time and operationally ready time divided by the sum of the corrective and preventive maintenance actions performed.

$\overline{M}$ = Mean Active Maintenance Downtime consisting of (for a given calendar interval) the sum of the active corrective and preventive maintenance downtime divided by the sum of the corrective and preventive maintenance actions performed (excluding cannibalization actions and associated downtime) and where all supply, support equipment and administrative downtime is considered to be operationally ready time.

thus:

$$Aa = \frac{\dfrac{\text{Operating Time + Ready Time}}{\text{Corrective Actions + Preventive Actions}}}{\dfrac{\text{Operating Time + Corrective Downtime + Preventive Downtime}}{\text{Corrective Actions + Preventive Actions}}}$$

$$= \frac{\text{Operating Time + Ready Time}}{\text{Operating Time + Ready Time + All Maintenance Downtime}}$$

$$= \frac{\text{Operating Time + Ready Time}}{\text{Total Elapsed Time}}$$

Using the above definition for MTBM and $\overline{M}$ and the further derivation for Aa, it is seen that Aa can also be defined as Operational Availability (as defined by the ORE Handbook and MIL-STD-778) with the supply, support equipment and administrative downtime treated as operationally ready time.

The Achieved Availability shown below for the current quarter and for the total 33 month cumulative data is based on the above definition and data from Tables C-2 through C-17 of Section D.

	3rd Quarter 1970	Cumulative Data 33 Months
Operating Time + Ready Time (hrs)	38,747	514,531
Corrective Actions Downtime (hrs)	3,144	69,881
Preventive Actions Downtime (hrs)	2,381	32,789
*Administrative Downtime (hrs)	10,718	169,349
*Supply Downtime (hrs)	13,554	159,461
*Support Equipment Downtime (hrs)	240	812
Total Operationally Ready Time	63,259	844,153
Total Elapsed Time	68,784	946,823
Achieved Availability	91.90%	89.2%

*Treated as Operationally Ready Time

Operational Availability
(Data Item 08-010-8)

The Operational Availability, as defined in the ORE Handbook, considers flight and ready time and all downtime for maintenance, supply, and administrative reasons. The detailed summations are presented in Tables C-1 through C-17, Section D. The trend by calendar quarter is shown in Table C-1 and graphically in Figures C-1 and C-2, pages C-9 and C-10, respectively.

The tables of Section D present the data for (1) the current calendar quarter and (2) the total cumulative data. The analysis is further subdivided to show comparisons between RVN, CONUS, and USAREUR operations for the above calendar periods.

The data inputs show the following operational availability, along with the change from the previous quarter:

3rd Quarter - 1970

	CONUS	Δ	RVN	Δ	USAREUR	Δ	All Locations	Δ
1. Operational Availability:	53.5%	-13.7%	62.2%	+4.7%	48.7%	-25.3%	56.3%	-6.6%
2. Not Ready Due to:								
a. Prev. Maint.	4.2%	+0.9%	4.0%	+0.5%	1.2%	-.05%	3.5%	+0.4%
b. Corr. Maint.	3.5%	+1.0%	6.7%	-6.6%	1.8%	+0.2%	4.6%	-3.7%
c. Supply	29.4%	+11.4%	7.3%	-6.8%	32.0%	+21.4%	20.0%	+5.5%
d. Admin.	9.4%	+0.4%	19.8%	+8.0%	16.3%	+4.2%	15.6%	+4.4%
Total Not Ready:	46.5%		37.8%		51.3%		43.7%	

33 Month Cumulative

	CONUS	Δ	RVN	Δ	USAREUR	Δ	All Locations	Δ
1. Operational Availability:	54.6%	+0.2%	52.1%	+0.6%	66.9%	-2.9%	54.3%	+0.2%
2. Not Ready Due to:								
a. Prev. Maint.	3.5%	+0.1%	3.8%	±0.0%	1.4%	±0.0%	3.5%	±0.0%
b. Corr. Maint.	4.1%	-0.1%	9.8	-0.2%	1.8%	-0.1%	7.4%	-0.2%
c. Supply	22.0%	+0.6%	14.9%	-0.3%	15.3%	+2.9%	16.9%	+0.3%
d. Admin.	15.8%	-0.8	19.4	-0.1%	14.6%	+0.1%	17.9%	-0.3%
Total Not Ready:	45.4%		47.9%		33.1%		45.7%	

The operational availability presentation readily shows excursions from previous quarterly report averages. Examination of the Tables of Section D permits further isolation of gross changes by operating theater to specific activities.

3rd Quarter 1970

CONUS - The decrease (-13.7%) in operational availability is due to increases in maintenance, supply, and administrative downtime.

RVN - Operational availability has increased (+4.7%) as a result of decreases in maintenance and supply downtime.

USAREUR - The operational availability has decreased significantly (-25.3%) primarily due to increases in supply downtime (+21.4%) and less significant increases in administrative downtime.

ALL LOCATIONS - The overall operational availability showed a slight decrease (-6.6%) as a result of an increase in supply, preventive maintenance, and administrative downtime.

Cumulative - 33 Months

CONUS - The cumulative operational availability increased (0.2%) as a result of a general decrease in administrative and corrective maintenance downtime.

RVN - An increase (+0.6%) in the cumulative operational availability is the result of a reduction in corrective maintenance, supply, and administrative downtime.

USAREUR - Overall operational availability decreased lightly due to a small increase in supply downtime.

ALL LOCATIONS - The cumulative operational availability increased (+0.2%) as a result of a decrease in administrative, and corrective maintenance downtime.

Analysis of aircraft downtime reported for supply shortages of components was performed and the following list cites the top ten contributors to operational unavailability for supply reasons over the 33 month period of this report. Items are ranked in descending order for the combined operational theaters, and show the reduction of overall availability in the specified theater due to shortages of the listed component.

Rank	Component	CONUS	RVN	USAREUR	ALL LOCATIONS
1	Engine Fuel Control P/N 571078 FSN 2915-928-3906	0.7%	0.9%	4.3%	1.2%
2	Tail Rotor Head Assy. P/N 65111-07000-047, -045 65110-07000-047 FSN 1615-975-0475	2.6%	0.1%	0.4%	0.9%
3	Clutch Assy. APP P/N S6137-91000-015, -016, -013 FSN 1615-915-7142	2.3%	0.3%	0.0%	0.8%
4	Tail Rotor Blade Assy. P/N 65160-00001-045,-042,-041 FSN 1615-966-6051	0.3%	1.1%	1.3%	0.8%
5	Engine Model T73-P-1 P/N 572200 & 6430-81100-043 FSN 2840-904-2461	0.7%	0.7%	0.0%	0.7%
6	Main Rotor Head Assy. P/N 6410-20004-014,-015,-016 -017,-023,-027 FSN 1616-915-7142	0.1%	1.0%	0.0%	0.5%
7	Speed Actuator P/N 6430-80326-101 FSN 2995-891-8461	1.0%	0.0%	0.4%	0.5%
8	Support Assy., Bearing P/N 6435-60[illegible]8-010 S39003-001 FSN 1615-915-7013	1.5%	0.0%	0.1%	0.4%
9	Main Rotor Blade Assy. P/N 6415-20201-041 FSN 1615-842-6277	0.5%	0.5%	0.0%	0.4%
10	Core, Flex Shaft P/N 572781 FSN 2995-914-5940	0.2%	0.5%	0.0%	0.4%

OPERATIONAL AVAILABILITY
(DOWN-TIME TRENDS)

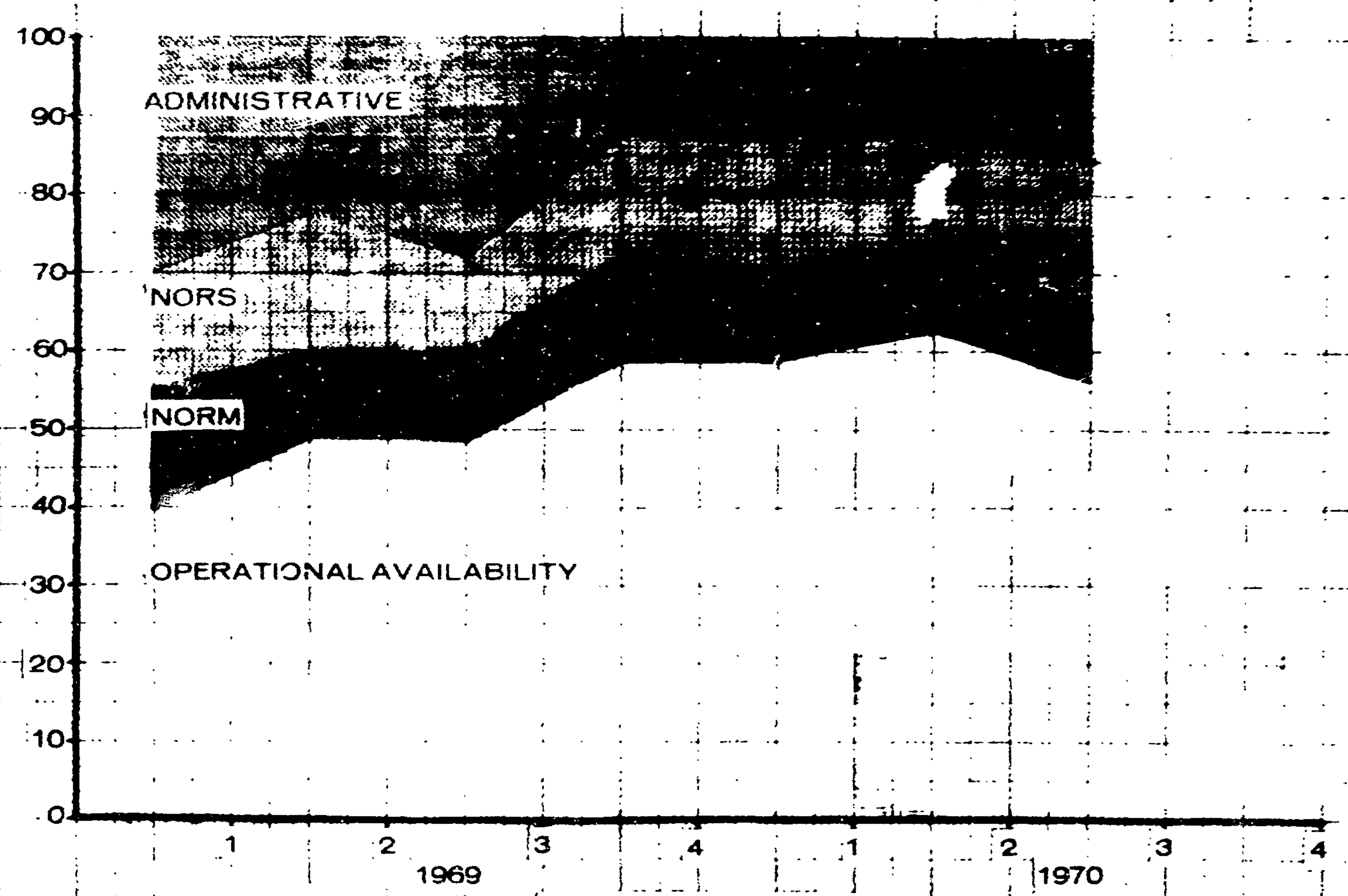
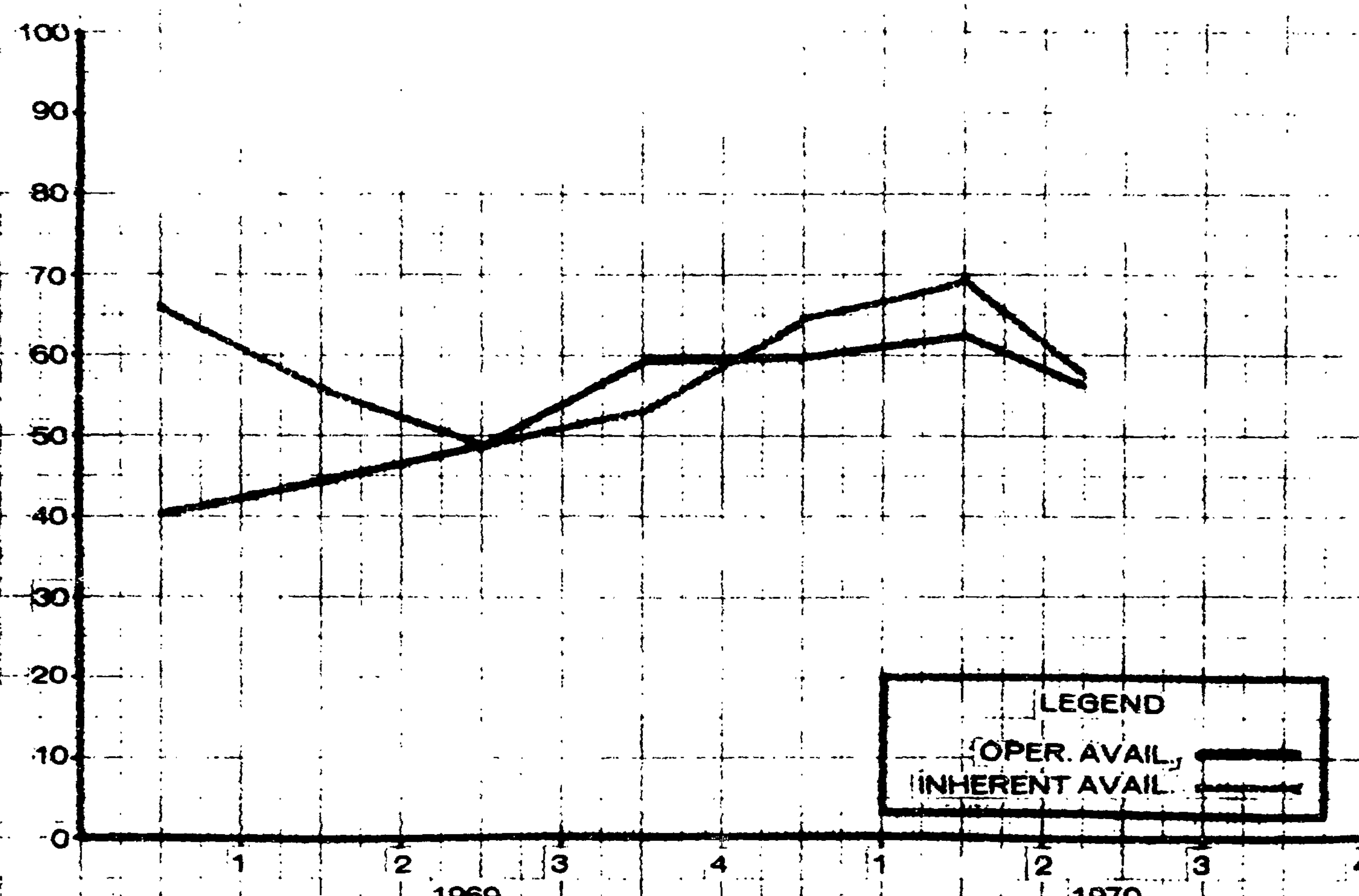


FIGURE C-1

OPERATIONAL & INHERENT AVAILABILITY-ALL LOCATIONS



CALENDAR QUARTER

FIGURE C-2

Average Flight Hours per Aircraft
(Data Item 08-010-10)

Analysis of data processed from the Daily Flight Records, SA 978-3, is shown in Tables C-18 through C-26 of Section D. The data is presented for (1) the current calendar quarter, and (2) the total cumulative data.

The analysis is further subdivided in these tables to show each characteristic by USAREUR, RVN and CONUS to compare operational theaters.

The average flight hours accumulated on each aircraft by serial number and location is shown in Table C-18. For all reported aircraft combined, the information is as follows:

	3rd Quarter 1970	33 Months
Average Flight Hours Accrued Per Aircraft	68.2	761.8
Average Flight Hours Accrued - (Standard Deviation)	46.5	469.6

This shows a monthly average flight hour per aircraft of 23.1 hours based on the 33 month average.

Average Flight Duration
(Data Item 08-010-11)

The average flight duration, with standard deviation, is displayed in Table C-18 of Section D for each aircraft and all aircraft combined. The data is presented by (1) the current calendar quarter and (2) the total cumulative data.

Further subdivisions are displayed in Table C-13 to show average flight duration in USAREUR, RVN and CONUS for comparing operational theaters.

For all reported aircraft combined, the information is as follows:

	3rd Quarter 1970	33 Months
Average Flight Duration	1.81	2.56
Average Flight Duration - Standard Deviation	1.17	1.07

SYSTEM ANALYSIS FROM: 680101 TO: 700930 LOCATION - ALL

TABLE A-1

REV 3

FLIGHT TIME - 47992.6 AIRCRAFT SERIAL NO. RANGE - ALL

SYSTEM SUMMARY

SYSTEM CODE	NOMENCLATURE	NO. OF FAILURES	SYSTEM FAILURE RATE	SYSTEM MTBF	SYSTEM RELIABILITY(1HR)	NO. OF ABORTS	ABORT RATE	MAN-HOURS	ACT. EMT
******************	****************	********	************	********	****************	******	*******	*********	*********
JFTD12A-4A	TURBO-SHAFT ENG	1032	.021503	47.	.978726	109	.002271	6359.2	3158.9
T-62-T-16A1	APP	344	.007168	140.	.992858	75	.001563	1087.9	658.9
112010	COCKPIT CANOPY	146	.003042	329.	.996962	0	.000000	197.2	168.5
112020	FORWARD FUSELAGE	130	.002709	369.	.997295	0	.000000	570.8	424.2
112030	TAIL ROTOR BOOM	49	.001021	979.	.998980	0	.000000	161.6	124.4
112040	TAIL ROTOR PYLON	72	.001500	667.	.998501	0	.000000	654.8	397.0
112050	STABILIZER	107	.002230	449.	.997773	0	.000000	342.7	246.3
117500	ARMOR PLATE	10	.000208	4799.	.999792	0	.000000	10.9	12.3
118000	MLG SUPPORT INST	79	.001646	608.	.998355	1	.000021	202.0	161.2
125010	COCKPIT FURNISH	81	.001688	593.	.998314	0	.000000	61.5	61.5
132510	NOSE LANDNG GEAR	97	.002021	495.	.997981	0	.000000	370.7	183.6
132520	NLG WHEEL TIRE	17	.000354	2823.	.999646	1	.000021	58.4	30.1
132530	MAIN LANDNG GEAR	123	.002563	390.	.997440	1	.000021	605.1	267.8
132540	MLG WHEEL TIRE	158	.003292	304.	.996713	1	.000021	338.0	239.3
132550	TAIL SKID	196	.004084	245.	.995924	0	.000000	282.5	209.4
132560	POD LANDING GEAR	2	.000042	23996.	.999958	0	.000000	10.5	6.5
144010	COLLECTIVE CONTR	52	.001083	923.	.998917	2	.000042	83.7	68.0
144020	CYCLIC CONTROLS	85	.001771	565.	.998230	2	.000042	179.1	129.4
144030	DIRECTIONAL CONT	222	.004626	216.	.995385	2	.000042	685.7	400.6
151000	MAIN ROTOR HEAD	409	.008522	117.	.991514	12	.000250	3249.7	1310.5
151100	TAIL ROTOR HEAD	199	.004146	241.	.995862	2	.000042	879.7	461.1
151500	MAIN ROTOR BLADE	483	.010064	99.	.989986	12	.000250	1172.4	663.3
151600	TAIL ROTOR BLADE	519	.010814	92.	.989244	2	.000042	1079.1	732.2
243000	APP HYD START	194	.004042	247.	.995966	23	.000479	598.3	288.5
263510	MAIN TRANSMISION	386	.008043	124.	.991989	21	.000438	3139.5	1628.4
263520	INTERMED XMSN	49	.001021	979.	.998980	2	.000042	330.7	148.6
263530	TAIL TRANSMISION	28	.000583	1714.	.999417	1	.000021	305.2	113.4
263540	TAIL DRIVE SHAFT	200	.004167	240.	.995841	4	.000083	863.7	463.5
263550	APP CLUTCH	162	.003376	296.	.996630	13	.000271	573.7	380.7
263560	ROTOR BRAKE	404	.008418	119.	.991617	10	.000208	821.5	637.4
263570	MGB OIL COOLER	326	.006793	147.	.993230	15	.000313	764.5	511.0
293000	POWER PLANT	28	.000583	1714.	.999417	1	.000021	75.5	56.6
293010	ENGINE EXHAUST	525	.010939	91.	.989120	10	.000208	1043.6	715.7
293020	ENGINE CONTROLS	274	.005709	175.	.994307	29	.000604	854.4	525.6
293030	ENGINE HYD START	98	.002042	490.	.997960	29	.000604	201.4	141.3
293040	ENGINE MOUNTS	89	.001854	539.	.998147	0	.000000	170.8	118.3
293050	EAPS	161	.003355	298.	.996651	3	.000063	302.1	235.3
413000	ENG ANTIICE DUCT	1	.000021	47993.	.999979	0	.000000	.5	.5
415000	CABIN HEATER	24	.000500	2000.	.999500	0	.000000	47.4	40.4
415500	ENG ANTIICE CONT	1	.000021	47993.	.999979	0	.000000	.5	.5
425510	AC ELECTRICAL	33	.000688	1454.	.999313	6	.000125	94.6	85.9
425520	GENERATOR	38	.000792	1263.	.999209	17	.000354	75.0	52.6
425530	DC ELECTRICAL	17	.000354	2823.	.999646	0	.000000	33.8	30.4
425540	BATTERY	11	.000229	4363.	.999771	0	.000000	4.8	4.8
445510	EXTERIOR LIGHTS	313	.006522	153.	.993499	1	.000021	332.4	258.7
445520	INTERIOR LIGHTS	33	.000688	1454.	.999313	2	.000042	16.2	15.2
456510	PRIMARY SERVO	104	.002167	461.	.997835	0	.000000	454.1	255.6
456520	AFCS SERVOS	44	.000917	1091.	.999084	5	.000104	471.1	285.8
456530	TAIL ROTOR SERVO	12	.000250	3999.	.999750	1	.000021	36.2	24.2
456540	UTILITY HYDRALIC	111	.002313	432.	.997690	23	.000479	256.8	191.7
456550	FLT CONT HYDRAUL	197	.004105	244.	.995904	13	.000271	309.5	302.1
456560	CARGO HOIST HYD.	368	.007668	130.	.992361	53	.001104	1496.4	949.6

PAGE D-A1

SYSTEM ANALYSIS FROM: 660101 TO: 700930 LOCATION - ALL

TABLE A-1 (cont)

FLIGHT TIME - 47992.6 AIRCRAFT SERIAL NO. RANGE - ALL

SYSTEM CODE	NOMENCLATURE	NO. OF FAILURES	SYSTEM FAILURE RATE	SYSTEM MTBF	SYSTEM RELIABILITY(1HR)	NO. OF ABORTS	ABORT RATE	MAN-HOURS	ACT. EMT
463000	FUEL	243	.005063	198.	.994950	7	.000146	1168.8	710.8
492030	CARGO SUSPENSION	60	.001250	800.	.998751	1	.000021	139.8	94.3
495010	WINDSHIELD WIPER	61	.001271	787.	.998730	0	.000000	58.8	55.4
495020	CARGO WINCH	290	.006043	165.	.993976	32	.000667	1382.6	711.8
495500	FIRE DETECTION	79	.001646	608.	.998355	2	.000042	121.0	114.6
495510	VOICE WARN ASH19	3	.000063	15998.	.999937	0	.000000	3.1	2.1
496550	LOAD LEVELER	21	.000438	2285.	.999563	0	.000000	41.3	26.7
514500	INSTRUMENTS	467	.009731	103.	.990317	19	.000396	612.4	529.5
514511	ASN-43 COMPASS	62	.001292	774.	.998709	0	.000000	104.9	89.6
514520	FLT INSTRUMENTS	165	.003438	291.	.996568	0	.000000	123.9	124.1
514530	NAV INSTRUMENTS	4	.000083	11998.	.999917	0	.000000	2.1	2.1
514540	ENG INSTRUMENTS	140	.002917	343.	.997087	2	.000042	124.2	114.1
514550	XMSN INSTRUMENTS	1	.000021	47993.	.999979	0	.000000	1.2	1.2
514560	WARNING INSTR	64	.001334	750.	.998667	1	.000021	101.6	66.6
579000	AFCS AN/ASW-29	53	.001104	906.	.998896	7	.000146	80.8	71.9
579010	AFCS AMPLIFIER	78	.001625	615.	.998376	4	.000083	108.0	90.6
579020	VERTICAL GYRO	29	.000604	1655.	.999396	7	.000146	47.0	38.1
579030	REMOTE STICK	72	.001500	667.	.998501	2	.000042	105.3	100.4
626010	ARC-54 VHF	365	.007605	131.	.992424	7	.000146	502.9	493.9
626020	ARC-134 VHF	22	.000458	2181.	.999542	0	.000000	16.2	14.5
626030	T-366A VHF	3	.000063	15998.	.999937	0	.000000	2.7	2.7
626040	ARC-73 VHF	2	.000042	23996.	.999958	0	.000000	6.0	3.0
626050	ARC-131	19	.000396	2526.	.999604	0	.000000	11.4	11.4
636010	ARC-51 UHF	104	.002167	461.	.997835	3	.000063	120.[illegible]	[illegible]
646010	AIC-12 ICS	148	.003084	324.	.996921	1	.000021	105.[illegible]	[illegible]
656010	APX-44 IFF	55	.001146	873.	.998855	0	.000000	71.8	[illegible]
656020	APX-72 IFF	15	.000313	3200.	.999687	0	.000000	21.0	21.0
716010	ARN-82 VOR	35	.000729	1371.	.999271	0	.000000	55.9	55.9
716020	ARN-59 ADF	2	.000042	23996.	.999958	0	.000000	2.5	2.5
716030	ARN-83 ADF	133	.002771	361.	.997233	0	.000000	221.3	190.3
915000	EMERGENCY EQUIP	2	.000042	23996.	.999958	0	.000000	.8	.8
TOTAL AIRCRAFT		11640	.242537	4.	.784634	599	.012481	37662.2	22530.9

TABLE D-42

Table A-3

COMPONENT CONTROL

Nomenclature	Part Number	FSN	Quantity of Unscheduled Removals	MTBUR	TBO or Retirement	MTBR
APU Gas Turbine				828		828
	37747-100	2835-931-4775	58			
	37747-0	FSN Pending				
	T62-T16A	FSN Pending				
	T62-T16A1	2835-931-4775	0			
Blade, Main Rotor				1215	5000	1017
	6415-20201-041	1615-842-6277	233			
	6415-20101-041	1615-052-0408	4			
Blade, Tail Rotor				345		345
	65160-00001-045	1615-986-6051	549			
	65160-00001-042	1615-915-7003	5			
	65160-00001-041		2			
Cable Assy, Cargo Hoist				511		511
	S6050-62356	FSN Pending	55			
	S6050-62356-2	1680-019-5277	39			
	BWR-4013	1680-019-5277	0			
	BWRE4005-1	FSN Pending	0			
Cargo Hook				706		706
	SP7070	1560-052-0475	0			
	SP7070-1	1680-994-1134	0			
	6450-62100-102	1680-994-1134	65			
	6450-62100-101	1680-994-1134	3			

Table A-3 (Cont)

COMPONENT CONTROL

Nomenclature	Part Number	FSN	Quantity of Unscheduled Removals	MTBUR	TBO or Retirement	MTBR
Cargo Lashing Reels, Load Leveler				19,1970		191970
	SP7063-3	1560-052-0467	0			
	SP7063-5	1560-932-3655	0			
	6420-60017-105	1560-932-3655	1			
Clutch Assy, APP				480	500	311
	S6137-91000-013	1615-960-1543	6			
	S6137-91000-015	1615-915-7142	94			
	S6137-91000-016	FSN Pending	0			
Decoupler Device Cargo Hoist				1655		1655
	6450-62352-104	1680-878-5215	14			
	4SS-3089-0013	1680-938-3100	0			
	6450-62352-103	1680-936-2408	2			
	4SS-3501-001	1680-936-2408	2			
	6450-62352-102		6			
	1640-62326-041		5			
*Gear Box and Servo Assembly				3000	1200	989
	6435-66001-042	1615-902-4801	16			
	6435-66001-041	1615-018-6426	0			

*S/N of gear box is to be used as assembly S/N.

Table A-3 (Cont)

COMPONENT CONTROL

Nomenclature	Part Number	FSN	Quantity of Unscheduled Removals	MTBUR	TBO or Retirement	MTBR
Engine Assembly, Turbo				667	800	466
	JFTD12A1	2840-919-7975	0			
	410400	2840-919-7975	0			
	572200	2840-904-2461	143			
	T73-P-1	2840-904-2461	1			
	JFTD12A4A	2840-904-2461	0			
Gear Box, Cargo Hoist				23996		23996
	6435-63001-013	1680-831-0480	0			
	6435-63001-016	1680-936-2391	0			
	6435-63001-017	1680-781-6655	2			
Gear Box, Intermediate				1778	1200	873
	6435-66400-041	1615-901-1914	0			
	6435-66400-042	1615-902-5092	0			
	6435-66400-043	1615-986-6169	27			
Gear Box, Main				615	800	448
	6435-20400-041	1615-984-5589	0			
	6435-20400-046	1615-984-5605	0			
	6435-20400-047	1615-983-0065	78			

Table A-3 (Cont)

COMPONENT CONTROL

Nomenclature	Part Number	FSN	Quantity of Unscheduled Removals	MTBUR	TBO or Retirement	MTBR
Lug Assy. Eng.			0			
	6430-80007-07	2840-988-0181				
Main Rotor Head Assy				593	400	291
	6410-20004-011	1615-895-4509	0			
	6410-20004-013	1615-895-5373	1			
	6410-20004-015	1615-938-1711	37			
	6410-20004-017	1615-717-7667	2			
	6410-20004-023	1615-809-2380	34			
	6410-20004-025	FSN Pending	2			
	6410-20004-014	FSN Pending	1			
	6410-20004-016	FSN Pending	4			

Table A-3 (Cont)

COMPONENT CONTROL

Nomenclature	Part Number	FSN	Quantity of Unscheduled Removals	MTBUR	TBO or Retirement	MTBR
Damper Assy, Main Rotor				15156	400	395
	6410-26200-041	1615-983-7321	15			
	6410-26200-043	1615-803-2371	3			
Cylinder, Damper	6410-26001-102	FSN Pending	0			
	6410-26001-103	FSN Pending	0			
	6410-26000-012	1615-982-0554	1			
Motor, Hyd., Cargo Hoist				47993		47993
	PMF-117B006A	1650-993-5462	1			
Particle Separator Eng Air Inlet				1959		1959
	6430-91000-011	FSN Pending	12			
	6430-91000-012	FSN Pending	29			
	6430-91000-041	FSN Pending	0			
	6430-91000-047	FSN Pending	4			
	6430-91000-042	FSN Pending	0			
	6430-91000-048	FSN Pending	4			
Pump and Actuator, Cargo Hoist				923		923
	IPV-093L001-S	1650-831-0273	0			
	6465-20021-101	1650-831-0273	52			
Servo, AFCS				1171	1000	672
	S6265-62551-10	6615-829-8443	41			

Table A-3 (Cont)

COMPONENT CONTROL

Nomenclature	Part Number	FSN	Quantity of Unscheduled Removals	MTBUR	TBO or Retirement	MTBR
Servo Cylinder Assy, Load Leveler, Short				23996		23996
	6465-62100-015	1650-934-8448	0			
	6465-62100-017	1680-934-8434	0			
	6465-62100-019	1650-069-3344	2			
	6465-62100-021	1680-857-3285	0			
Servo Cylinder Assy, Load Leveler, Long				11998		11998
	6465-62100-018	1650-938-8380	1			
	6465-62100-022	1650-857-3286	0			
	6465-62100-016	1650-934-8447	0			
	6465-62100-020	1650-069-3355	2			
	6465-62100-019	1650-069-3344	1			
Servo, Main Rotor Primary				1655	1000	751
	S1565-20421-10	1615-975-0355	87			
Strut and Fork Assy, Main Ldg Gear				2182		2182
	6425-50102-011	1560-H54-0505	2			
	6425-50102-014	1620-H23-1122	17			
	6425-50102-013	1620-898-9587	7			
	6425-50102-012	1620-934-8424	3			
	6425-50102-015	1620-852-6688	15			

Table A-3 (Cont)

COMPONENT CONTROL

Nomenclature	Part Number	FSN	Quantity of Unscheduled Removals	MTBUR	TBO or Retirement	MTBR
Strut Assy, Nose Landing Gear				2823		2823
	6425-50502-011	1620-988-0085	11			
	6425-50501-011		6			
Tail Rotor Head Assembly				1043	800	559
	65110-07000-047	FSN Pending	5			
	65110-07000-013	1615-[illegible]-4364	24			
	65111-07000-045	1615-932-9816	0			
	65111-07000-047	1615-975-0475	17			
Spindle Assy, T.R.	65112-07002-044	1615-979-8575	0			
	65112-07002-046	1615-054-3535	0		2600	
Valve Anti-Icing				2341		2341
	67-[illegible]-001	2995-992-9408	0			
	6430-60131-101	2995-992-9408	41			
	32-0251-7	2995-992-9408	0			
Valve, Fuel Shutoff				47993		47993
	6430-62045-101	2915-897-4078	1			
	A61245	2915-897-4078	0			

Table B-1 Rev. J.

CH-54A Total System On-Aircraft Maintenance Downtime per Flight Hour

Third Quarter 1970

		CONUS	RVN	USAREUR	All Locations	33 Month Cumulative Total CONUS	RVN	USAREUR	All Locations
I.	Total Flight Hours	938.4	1,693.5	369.3	3,001.2	10,799.8	34,966.2	2226.6	47,993.5
II.	Corrective Maintenance								
	a) Active Elapsed Hours	619.9	860.8	198.0	1,678.7	7,349.1	17,136.3	1,114.6	25,600.0
	b) Corrective Actions	359	381	109	849	4,241	8,731	564	13,536
	c) $MTTR_e$ (1)	1.7	2.2	1.8	2.0	1.7	2.0	2.0	1.9
	d) Active Manhours	1040.5	1721.2	273.0	3034.7	12,411.8	31,725.4	1587.1	45,724.3
	e) $MTTR_m$ (1)	2.9	4.5	2.5	3.6	2.9	3.6	2.8	3.4
	f) Avg. Manhours/Down Hours	1.7	2.0	1.4	1.8	1.7	1.9	1.4	1.8
	g) Active MMH/FH	1.11	1.02	0.74	1.01	1.15	0.91	0.72	0.95
III.	Preventive Maintenance (3)								
	a) Active Elapsed Hours	1294.8	2,703.2	616.0	4,614.0	17,199.8	63,674.1	4,536.5	85,410.2
	b) Preventive Actions	674	644	272	1,590	6,678	17,823	1,944	26,445
	c) $MPMT_e$ (2)	1.9	4.2	2.3	2.9	2.6	3.6	2.3	3.2
	d) Active Manhours	4,224.7	4,999.4	1,986.0	11,210.1	57,843.1	191,070.2	10,685.5	259,598.5
	e) $MPMT_m$ (2)								
	f) Avg. Manhours/Down Hour	3.3	1.8	3.2	2.4	3.4	3.0	2.4	3.0
	g) Active Manhours/Flt. Hour	4.50	2.95	5.38	3.73	5.36	5.46	4.80	5.41
IV.	Combined Corrective/Preventive Maintenance								
	a) Active Elapsed Hours	1914.7	3,564.0	814.0	6,292.7	24,548.9	80,810.4	5651.1	111,010.2
	b) Total Maintenance Actions	1033	1025	381	2,439	10,919	26,554	2508	39,981
	c) Avg. Active Elapsed Hours/ Maintenance Action	1.9	3.5	2.1	2.6	1.7	2.0	2.0	1.9
	d) Avg. Active Down Hour/Flight Hour	2.0	2.1	2.2	2.1	2.3	2.3	2.5	2.3
	e) Active Manhours	5,265.2	6,720.6	2,259.0	14,244.8	70,254.9	222,795.6	12,272.6	305,322.8
	f) Avg. Manhours/Maintenance Action (3)	5.1	6.6	5.9	5.8	6.4	8.4	4.9	7.6
	g) Avg. Manhour/Down Hour	2.7	1.9	2.8	2.3	2.9	2.8	2.2	2.8
	h) Active Manhours/Flight Hours	5.6	3.9	6.1	4.7	6.51	6.37	5.52	6.36

Notes: (1) Mean Time to Repair, Elapsed or Manhours, for corrective maintenance actions (Refer to ORE Handbook).
(2) Mean Preventive Maintenance Time, Elapsed or Manhours, for preventive maintenance actions. (Refer to ORE handbook for definition.)
(3) Includes on-aircraft scheduled (TBO) removal actions at both Org. and Direct Support Activities.

[illegible] Rev. J

[illegible] Mean Time [illegible] Repair, [illegible] ($MTTR_e$ [illegible]) and Man-hours/Elapsed Hours

3rd Quarter 1970

[illegible]	[illegible]	[illegible] $MTTR_e$	[illegible] MH/EH	RVN $MTTR_e$	RVN MH/EH	[illegible]AREUR $MTTR_e$	[illegible]AREUR MH/EH	ALL LOCATIONS Qty. Actions	ALL LOCATIONS $MTTR_e$	ALL LOCATIONS MH/EH
[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2,439	2.6	2.3
[illegible]		[illegible]	[illegible]	[illegible]	1.5	[illegible]	[illegible]	1,[illegible]0	2.[illegible]	2.4
[illegible]		[illegible]	[illegible]	[illegible]	1.[illegible]	1.[illegible]	1.[illegible]	[illegible]	[illegible]	[illegible]
[illegible]		1.[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	744	1.9	2.6
[illegible]		6.[illegible]	[illegible]	[illegible]	[illegible]	7.[illegible]	[illegible].6	65	7.0	3.9
[illegible]		[illegible]	[illegible]	1[illegible].5	[illegible]	17.8	[illegible].5	126	13.8	2.4
Special		[illegible]	[illegible]	75.6	[illegible]	NR	NR	5	45.5	.25
[illegible]		NR	NR	NR	NR	NR	NR	0	NR	NR
Transfer		NR	NR	NR	NR	NR	NR	0	NR	NR
[illegible] Intervals		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	41	5.5	2.4
[illegible] Maintenance		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	84[illegible]	[illegible]	1.8
By Major Sub-system										
Airframe	[illegible]	1.1	[illegible]	1.5	1.1	1.5	1.0	70	1.4	1.2
Landing Gear	[illegible]	1.4	[illegible]	2.1	2.8	1.3	1.0	46	1.6	1.9
Mech. Flight Controls	[illegible]4030	1.7	[illegible]	1.3	1.6	[illegible]	1.0	43	1.4	1.5
Rotor & Blades	[illegible]51600	1.6	1.8	1.8	2.2	1.5	1.6	1[illegible]	1.7	2.0
Powerplant ([illegible])	[illegible]3050	2.4	1.8	3.0	1.8	[illegible]	1.5	144	2.6	1.8
Aux. Powerplant (APP)	[illegible]	[illegible]	[illegible]	1.7	1.5	1.[illegible]	1.0	[illegible]	[illegible]	[illegible]
Transmission	[illegible]80	2.[illegible]	[illegible]	4.1	2.5	[illegible]	1.7	101	3.4	2.3
Heater and Anti-Ice	[illegible]	0.7	1.[illegible]	NR	NR	NR	NR	1	0.7	1.0
Electrical	[illegible]	[illegible]	[illegible]	0.7	1.2	[illegible]	1.[illegible]	[illegible]	0.7	1.1
Hydraulic	[illegible]	[illegible]	[illegible]	1.9	1.4	[illegible]	[illegible]	[illegible]	[illegible]	1.4
Fuel	[illegible]	[illegible]	1.0	7.1	1.9	NR	NR	15	5.9	1.9
[illegible]	[illegible]655[illegible]	[illegible]	[illegible]	[illegible].6	[illegible]	1.3	1.3	47	[illegible]	1.9
Instruments	[illegible]456[illegible]	[illegible]	[illegible]	[illegible].6	1.1	1.[illegible]	1.0	66	0.7	1.1
AF[illegible]	[illegible]70030	[illegible]	[illegible]	0.3	1.0	2.0	1.5	18	[illegible].7	1.3
Communications	[illegible]	[illegible]	[illegible]	0.6	1.0	1.1	1.[illegible]	4[illegible]	0.6	1.0
Navigation	[illegible]6030	1.[illegible]	[illegible]	0.8	1.5	1.5	1.0	13	1.1	1.1
Emergency Equipment	[illegible]	NR	NR	NR	NR	NR	NR	NR	NR	NR
By Individual Components										
[illegible] Months Cumulative Average										

Presented for the 33-month cumulative data from all locations combined in the Component Corrective Maintenance Summary, Table B-3, Pages D-B4 through D-B43.

Table C-1 Rev J

Operational Availability and Downtime Trends

Operational Availability - [illegible] by Quarter	[illegible] 1969 4th Qtr	[illegible] 1970 1st Qtr	[illegible] 1970 2nd Qtr	[illegible] 1970 3rd Qtr	RVN 1969 4th Qtr	RVN 1970 1st Qtr	RVN 1970 2nd Qtr	RVN 1970 3rd Qtr
1. Operational Availability	55.9%	56.[illegible]%	67.[illegible]%	53.5%	58.[illegible]%	62.6%	57.5%	62.2%
2. Downtime due to:								
A. Preventive Maintenance	2.3%	3.0%	3.3%	4.2%	2.3%	2.2%	3.5%	4.0%
B. Corrective Maintenance	6.6%	6.1%	2.5%	3.5%	16.6%	12.4%	13.1%	6.7%
C. Supply - NORS	24.4%	22.5%	18.0%	29.4%	12.9%	14.4%	14.1%	7.3%
D. Support Equipment - NORS	0.0%	0.1%	0.0%	0.0%	0.0%	0.2%	0.0%	0.0%
E. Administrative	10.8%	11.7%	9.0%	9.4%	10.0%	8.2%	11.8%	19.8%
3. Total Not Ready	44.1%	43.4%	32.8%	46.5%	26.8%	37.4%	42.5%	37.8%
Operation Availability Cumulative Summation by Quarters								
1. Operational Availability	51.1%	52.4%	54.4%	54.6%	48.0%	49.7%	51.5%	52.1%
2. Downtime due to:								
A. Preventive Maintenance	3.8%	3.6%	3.4%	3.5%	4.0%	3.9%	3.8%	3.8%
B. Corrective Maintenance	4.2%	4.4%	4.2%	4.1%	9.6%	9.5%	10.0%	9.8%
C. Supply - NORS	19.6%	21.8%	21.4%	22.0%	15.[illegible]%	15.4%	15.[illegible]%	14.9%
D. Support Equipment - NORS	2.1%	0.1%	0.0%	0.0%	0.1%	0.1%	0.0%	0.0%
E. Administrative	19.2%	17.7%	16.6%	15.8%	23.1%	21.4%	19.5%	19.4%
3. Total Not Ready	48.9%	47.6%	45.6%	45.4%	52.0%	50.3%	48.5%	47.9%

Operational Availability - [illegible] by Quarter	USAREUR 1969 4th Qtr	USAREUR 1970 1st Qtr	USAREUR 1970 2nd Qtr	USAREUR 1970 3rd Qtr	ALL LOCATIONS 1969 4th Qtr	ALL LOCATIONS 1970 1st Qtr	ALL LOCATIONS 1970 2nd Qtr	ALL LOCATIONS 1970 3rd Qtr
1. Operational Availability	64.6%	54.0%	74.0%	48.7%	59.0%	59.3%	62.9%	56.3%
2. Downtime due to:								
A. Preventive Maintenance	1.3%	2.9%	1.7%	1.2%	2.0%	2.6%	3.1%	3.5%
B. Corrective Maintenance	1.6%	2.0%	1.6%	1.8%	10.6%	8.8%	8.3%	4.6%
C. Supply - NORS	16.2%	10.8%	10.6%	32.0%	16.7%	16.2%	14.5%	20.0%
D. Support Equipment - NORS	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.[illegible]%	0.0%
E. Administrative	16.5%	30.3%	12.1%	16.3%	11.7%	13.0%	11.2%	15.6%
3. Total Not Ready	35.6%	46.0%	26.0%	51.3%	41.0%	40.7%	37.1%	43.7%
Operation Availability Cumulative Summation by Quarters								
1. Operational Availability	73.4%	69.2%	69.8%	66.9%	50.5%	52.9%	54.1%	54.3%
2. Downtime due to:								
A. Preventive Maintenance	1.2%	1.3%	1.4%	1.4%	3.8%	3.6%	3.5%	3.5%
B. Corrective Maintenance	1.5%	1.8%	1.9%	1.8%	7.5%	7.5%	7.6%	7.4%
C. Supply - NORS	12.6%	12.7%	12.4%	15.3%	16.8%	17.0%	16.[illegible]%	16.9%
D. Support Equipment - NORS	0.0%	0.0%	0.0%	0.[illegible]%	0.1%	0.1%	0.0%	0.0%
E. Administrative	11.3%	15.0%	14.5%	14.6%	21.3%	19.8%	18.2%	17.9%
3. Total Not Ready	26.6%	30.8%	30.2%	33.1%	49.5%	48.0%	45.9%	45.7%

Table C-18 Rev. I

CH-54A Utilization Characteristics

Aircraft Serial No.	Flight Hours Per 3rd Qtr.70	Flight Hours Per 33 Mo.	Landings/Period 3rd Qtr.70	Landings/Period 33 Mo.	Avg. Hrs./Flight 3rd Qtr.70	Avg. Hrs./Flight 33 Mo.	Total Accumulated Flight Hrs. (At End of 3rd Qtr. 70)	Latest Location
[illegible]	*	[illegible]	*	30	*	2.10	1233.9	RVN (Strike)
[illegible]-18408	70.6	[illegible]	58	3307	4.71	4.75	1850.3	RVN
66-18409	69.5	[illegible]	89	[illegible]	4.96	4.54	1556.7	RVN
66-18410	121.5	1276.8	193	2587	1.96	1.73	1666.4	USAREUR
66-18411	*	1137.9	*	2476	*	4.95	1548.3	RVN
66-18412	143.4	1348.2	891	8227	1.86	1.36	1776.9	RVN
66-18413	112.8	1157.9	662	7572	1.82	1.93	157?.1	RVN
67-18414	*	409.0	*	712	*	2.69	628.8	RVN
67-18415	170.8	1704.4	1026	10803	1.84	1.88	1962.9	CONUS
67-18416	*	729.7	*	1674	*	1.78	1157.7	RVN
67-18418	109.0	1199.6	182	2643	1.88	1.65	1506.2	RVN
67-18419	64.9	1460.5	85	3471	4.33	4.70	1750.1	CONUS
67-18420	66.1	1202.5	93	3007	4.54	4.19	1455.0	RVN
67-18421	*	385.1	*	945	*	3.50	657.3	RVN
67-18422	*	1143.5	*	2464	*	2.43	1236.6	RVN
67-18423	53.4	196.6	150	483	1.48	1.61	346.7	CONUS
67-18424	*	1155.2	*	2855	*	2.81	1294.1	RVN
67-18425	*	665.4	*	1911	*	2.47	771.8	RVN
67-18426	126.3	1191.4	250	2525	1.83	1.69	1397.1	RVN
67-18427	64.7	1233.1	74	2770	4.04	3.82	1308.4	RVN
67-18428	121.8	1222.6	281	2785	1.62	1.60	1317.4	RVN
67-18429	90.8	1224.1	124	2854	3.95	3.50	1394.1	RVN
67-18430	128.6	1200.8	268	2964	2.22	1.45	1246.2	RVN
67-18431	*	1185.0	*	3035	*	2.56	1208.4	RVN
68-18432	*	928.0	*	2819	*	2.26	959.3	RVN
68-18433	139.9	764.0	269	1676	1.75	1.66	865.9	RVN

*

Sikorsky Aircraft DIVISION OF UNITED AIRCRAFT CORPORATION

TITLE EIGHTH (8th) QUARTERLY CH-53 READINESS REPORT

REPORT NUMBER PS 65-K-8

PREPARED UNDER N000 19-68-C-0471 MOD P00102

REPORT DATE 31 DECEMBER 1971

REPORT PERIOD APRIL 1971 - JUNE 1971

This report is applicable to the following aircraft model(s) and contract(s):

MODEL CONTRACT

Prepared by C. A. Canner/B. Pickering Checked by J. S. White

Approved by P. Sharko

REV	CHANGED BY	REVISED PAGE(S)	ADDED PAGE(S)	DELETED PAGE(S)	DESCRIPTION	DATE	APPROVAL

REVISIONS CONTINUED ON NEXT PAGE

ABSTRACT

A total of thirty (38) assemblies have been presented and discussed in the CH-53 Readiness Program over the preceeding 2 year period. In this the eighth (8th) and last report under the terms of the current contract, we will summarize some of the major items which include:

1. Continue mini-course and audi-scan training programs to help insure that maintenance personnel can attain a high degree of proficiency in the support of the various systems encompassed in the CH-53 helicopter.
2. Review possibility of improving structural integrity of lower personnel door.
3. Approve VECP 7383 to expedite availability of long spline drive shaft for the utility system hydraulic pump.
4. Approve Sikorsky Letter SE 5064 requesting ECP coverage to authorize carburizing internal areas of nose gear box gears.
5. Continue evaluation of PPG all glass and Goodyear composite windshield panels.
6. Expedite concurrence with ECP 1HS-T62-029 to introduce improved APU pressure switches into the supply system.
7. Modify in service clutch assemblies per ECP 7418.

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APPENDIXES:

Introduction

This report represents the eighth and last submittal under Sikorsky Aircraft's CH-53 Readiness Program. These quarterly reports, authorized by MOD P00102 to Contract N00019-68-C-0471, have been prepared and distributed by the Readiness Group within the Product Support Department under direction of the CH-53 Model Manager.

The major statistical input of this group was 3M data supplied by the Maintenance Support Office (MSO) through NATSF. Both manual and machine processing was used in reducing the data for analysis. 3M data was used to determine high cost items on the CH-53 in terms of manhour expenditures and component repairs/replacements. NORS and NORM data was analyzed and top problem items in NORS, NORM and 3M reported component failure areas identified. Once these top problem areas were identified, further analysis was conducted to determine the exact nature of the problem. Data inputs from a Sikorsky Readiness Representative, stationed at NARF, North Island, supplemented 3M data with information concerning depot level maintenance. This supplemental data was sifted and analyzed in order to pinpoint possible problem areas. Once identified, these problems were attacked from a number of directions. Areas were investigated with a view toward possible recommendations for:

(a) changes or revisions to MIMS and other handbooks, (b) development of Audi-Scan programs to assist in improving field maintenance techniques, (c) initiation of SICR action to change procurement levels for parts/components showing usage differing from programmed levels, (d) changes to priority listings for kit deliveries, (e) ECP action to improve current designs in order to increase readiness rates. Both short and long term solutions were investigated with the intent of providing the most effective and expedient solution possible.

Close coordination was maintained between the Readiness Group and other areas of Sikorsky Aircraft, Programs, Engineering, O&R, and areas of Product Support including Supply Support. Field Support and Technical Publications were kept abreast of the group's efforts to insure coordinated and meaningful action on the part of Sikorsky Aircraft to improve operational readiness of the CH-53 helicopter.

Report Format:

There are three basic sections within this report: ahort rate data. maintenance manhour data. and NOR hour data are included in the first section. This information. gathered from the 3M system. is presented in a graphic format.

The second section contains: (a) impact analysis information on selected components. Impact Analysis being a study of the logistics connected with certain time control components. Adequacy of spare parts provisioning is studied taking into account various parameters such as Time Between Overhaul (TBO), Aircraft Utilization Rates. Actual Mean Time Between Removals for Overhaul (MTBR for Overhaul). Depot Turn Around Time (TAT). aircraft and parts deliveries. etc. The output of the study is a comparison of projected parts/component requirements versus projected parts availability. Obviously. any major difference between the two outcomes would be cause for remedial action. (b) is devoted to problems analysis of areas affecting the Operational Ready Rates for the CH-53A/D aircraft. The format consists of an investigation summary and a number of action sheets stating particular problems. their effect on readiness. maintenance manhours. etc. and recommended action to alleviate these problems. Where an ECP is referenced. a flow chart is included to reflect its status. 3M data is used as an information source and an analytical study of this data indicates those areas where further research is required. The data is ranked by systems as contributors to NORS, NORM and component failure burdens for the aircraft. The major problems are further studied in order to determine what actions can be taken to improve the system or component. This analysis forms the basis of the action sheets presented.

The third section reflects the status of suggested actions to improve readiness of areas discussed in earlier reports. These are presented in narrative form and include charts or graphs where their use adds clarity to the presentation.

Details and background information, including the ranking determined from 3M data, are presented in the appendices. In this way the cursory reader is spared the maze of numbers and charts while the information is made available for those who want, or have, to be aware of these details.

Current Report

NOR and failure data for this report have an identical time frame: January 1971 through June 1971. The Abort Summary covers April 1971 through June 1971.

The Airframe, Rotor System, Landing Gear System, Transmission System, Flight Control System and Power Plant Support System occupy the first (6) positions in the system performance chart, and are responsible for 58.12% of all aircraft failures, based on MSO 4790. A2142-01 of 20 August 1971. All have been discussed in earlier reports.

Thirty-eight (38) assemblies responsible for significant contributions to CH-53 failure and NOR statistics have been discussed during the past two years in the readiness reports. In this the eighth (8th) and last report under the terms of the current contract, we will summarize some of the major points presented in lieu of introducing additional problem items.

1. Perhaps the greatest single item affecting aircraft readiness is the quality of maintenance available at the field level. This of course relates directly to the need for dynamic training programs. The personnel attrition rate imposes considerable strain on any squadron's qualified roster but sophisticated systems such as those encompassed in the CH-53 cannot be maintained in the same manner as those aircraft designed and fabricated a decade or two ago. This was evidenced when 3M data was analyzed for the many assemblies we have discussed, such as:

a. The high cannibalization rate of AFCS components.

b. The frequent entry in the action taken block "No Defect - Checked OK."

c. Mission aborts due to tires with "Bad or Worn Tread", "Skin Cracks" in the ramp. These should be detected and corrected during scheduled aircraft maintenance periods and not left for the flight crew to locate.

The training recommended by the contractor includes Audi-Scan and Mini-Courses on selected trouble spots and OJT on all phases of maintenance tailored to the CH-53 helicopters.

2. The process from "Need for an Improvement to Incorporation of that Improvement" is too costly timewise. Analysis conducted during preparation of these reports emphasized the need for more expedient methods for completing ECP actions. (i. e.)

a. Sikorsky Letter of Intent SEL 5154 was forwarded to NASC in October 1970. The contractor is not in receipt of either confirmation or rejection correspondence. Letter SEL 7733 is similarly in process having been forwarded to NASC in January 1971.

b. Sikorsky Letter SE 593 dated 12 February 1968 started the ball rolling to modify engine nacelle aft panels which were becoming charred due to exhaust impingement encountered under certain operational conditions. It was not until November 1970 that improved panels were installed on production aircraft. Kits for retrofit of in-service aircraft are scheduled for availability in February 1972.

c. It became apparent, shortly after deployment of the CH-53, in 1967, that the matri-switches in the AFCS control panel would not function in the sandy environment of SEA. An ECP was submitted to NASC in June 1971 which recommended installing protective boots to preclude dust contamination of these assemblies.

These few incidents have been mentioned only to point out the length of time required to complete ECP projects and amplify the need for an accelerated procedure to implement beneficial modifications to an aircraft system.

3. The abort rate for the CH-53 has displayed gradual improvement over the 3 years (84,317 flight hours) reviewed under this contract as noted in the abort graph in section one (1) of this report. The new or short plot of lines shows that aborts, when analyzed and adjusted to exclude erroneous entries from the 3M base data, have reached the Sikorsky predicted MTBA of 50 flight hours. (.020 Aborts/Hr)

The balance of the report is devoted to problems reviewed previously to highlight areas where additional effort might further improve aircraft readiness.

Fleet wide operationally ready rate statistics have been omitted from this report in order to maintain its unclassified status. Readiness information is available from other sources and unless a strong need for this type of information becomes evident, it will not be included in this or future reports.

DEFINITIONS

Mean Time Between Removal for Depot Overhaul/Repair (MTBR)

The Mean Time Since New or Overhaul of components being returned to a depot level facility for any reason. Components returned without TSO information are disregarded. NOTE: The number so generated cannot be used as a true reliability figure for the component because it will include returns for such items as maintenance or handling damage, etc.

3M Reported Failure

Maintenance Actions reported in 3M card codes 11, 21, and 31 having Action Taken Codes 1 through 9, B, C, or Z.

Depot Turn Around Time (TAT)

Time elapsed from receipt of component at depot facility until component returned to RFI status.

"Timely Tips"

A Sikorsky developed and prepared directive designed to keep our Field Support Representatives abreast of new maintenance techniques, etc.

"Sound Off"

An internal document used to provide comments from our representatives in the field to up date and improve Sikorsky publications.

Abreviations and Definitions

AFC	Airframe Change
ASO	Aviation Supply Office
BUNO	Bureau Number
ECP	Engineering Change Proposal
IGB	Intermediate Gear Box
IMA	Intermediate Maintenance Activity
LES	Local Engineering Specification
MAG	Marine Air Group
MEA	Maintenance Engineered Analysis (MEAR)
MGB	Main Gear Box
MR	Main Rotor
MTPR	Mean Time Between Removal for Depot Overhaul/Repair
NARF	Naval Air Rework Facility
NATSF	Naval Air Technical Services Facility
NASC	Naval Air Systems Command

NOR	Not Operationally Ready
NORIS	North Island, California
NORM	Not Operationally Ready - Maintenance
NORS	Not Operationally Ready - Supply
O & R	Overhaul and Repair
OJT	On Job Training
PMRC	Periodic Maintenance Requirement Cards
RFI	Ready for Issue
SEA	South East Asia
SICR	Supply Item Change Record
SS	Sikorsky Standard
TAT	Turn Around Time
TBO	Time Between Overhauls
TGB	Tail Gear Box
TR	Tail Rotor

SECTION I

ABORTS - NOR - MAINTENANCE MANHOURS

This section of the Readiness Report presents Abort, Not Operationally Ready, (NOR) and Maintenance Manhour (MMH) data in a readily understandable graphical form. The data is grouped by two (2) digit work unit codes (WUC), i.e.: aircraft sub-system - - airframe, flight controls, drives and transmissions, etc. - - and is presented in WUC order. Aborts, NOR and MMH charged to each work unit code are shown as a percentage of total in their particular category. The abort period covered by this report is April, May, and June 1971, the information having been retrieved from 3M data tapes received by Sikorsky. The graph presented in this section reflects aborts per hour (experience versus predicted) for the CH-53A and D. The abort rate line is computed using as a starting point September 1969 and 84 837.4 total flight hours.

During the period October 1969 - December 1969 the abort rate was .03904 per 9,784.0 flight hours (total flight hours 94,621.4) or one (1) abort every 25.613 flight hours.

During the period January 1970 - March 1970 the abort rate was .03353 per 8,766.8 flight hours (total flight hours 103,388.2) or one (1) abort every 29.819 flight hours.

During the period April 1970 - June 1970 the abort rate was .03021 per 13,370.5 flight hours (total flight hours 116,758.7) or one (1) abort every 33.095 flight hours.

During the period July 1970 through September 1970 the abort rate was .04100 per 9,999.5 flight hours (total flight hours 126,758.2) or one (1) abort every 24.389 flight hours.

The abort rate during the period October 1970 through December 1970 was .03744 per 9,132.5 flight hours (total flight hours 135,891.0) or one abort every 26.704 flight hours.

The abort rate during the period January 1971 through March 1971 was .03286 per 10,133.6 flight hours. (Total flight hours 146,024.6) or one abort every 30.431 flight hours.

The abort rate during the period April 1971 through June 1971 was .04485 for 9386.7 flight hours. (Total flight hours 155,411.3) or one abort every 22.297 flight hours; which represents an increase in the abort rate for this report period.

A detailed analysis of the data base covering both flight and ground aborts revealed that 44.89% of the recorded abort actions were the direct result of poor maintenance techniques, lack of aircraft familiarization, or inequities in the 3M reporting system. The last chart in this section of the report includes additional "Plots" which reflect the "Adjusted" abort rate.

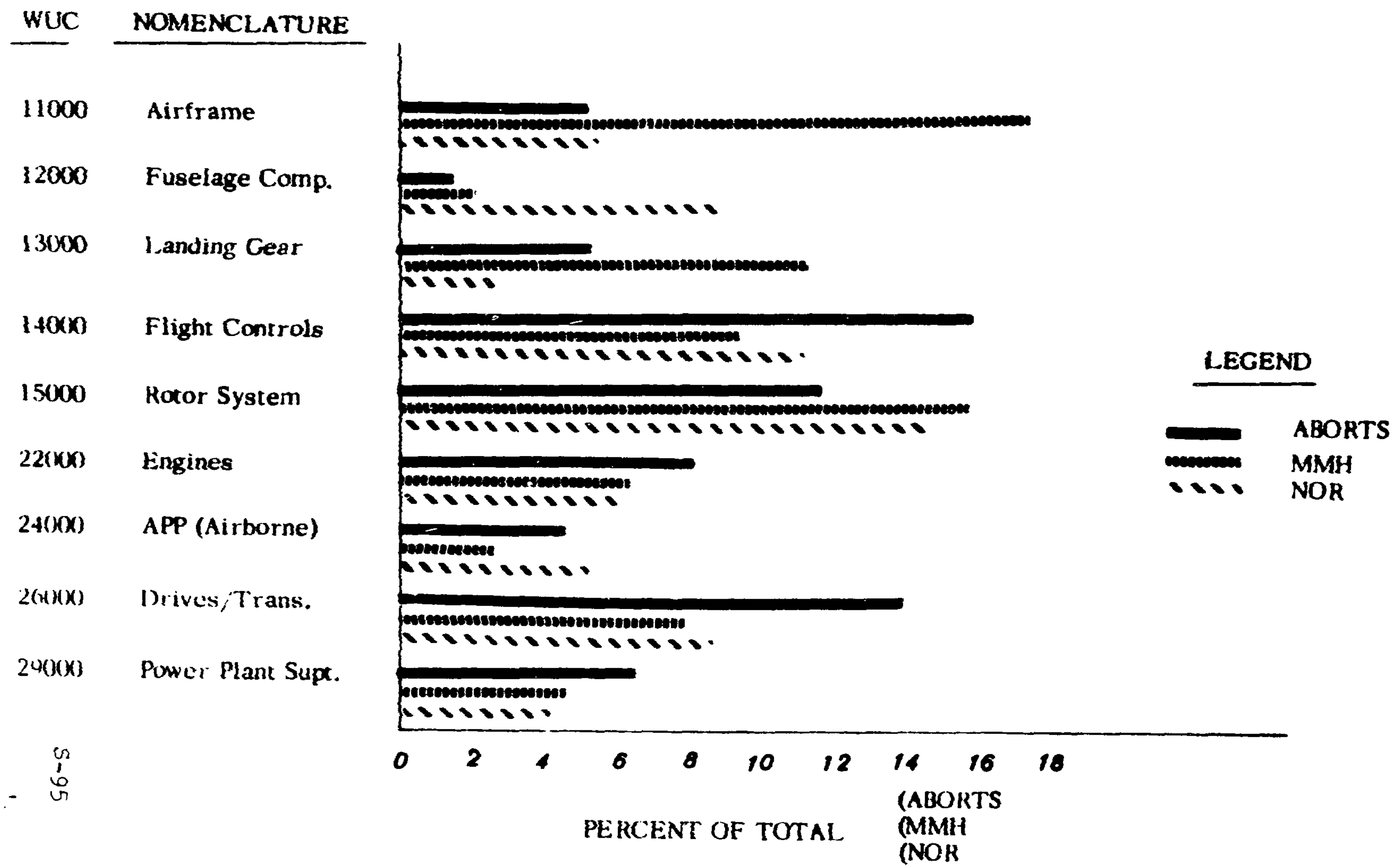
Attention is directed to this curve, covering four (4) quarters, July 1970 through June 1971. While the "Recorded" abort actions continue in an erratic course the "Adjusted" curve reflects a steady decline. This clearly highlights the need for a continuing vigorous training program to keep all field level personnel knowledgeable and highly efficient so that the need for maintenance can be detected and accomplished during scheduled maintenance periods and not left to be identified by flight crews which invariably results in aborted missions.

NOR data was extracted from 3M tapes covering October 1970 through March 1971. The maintenance manhour data base is a 3M report generated by MSO and also covers CH-53 operations from January 1971 through June 1971. Reference MSO-4790, A2142-1 655-02 of 20 August, 1971.

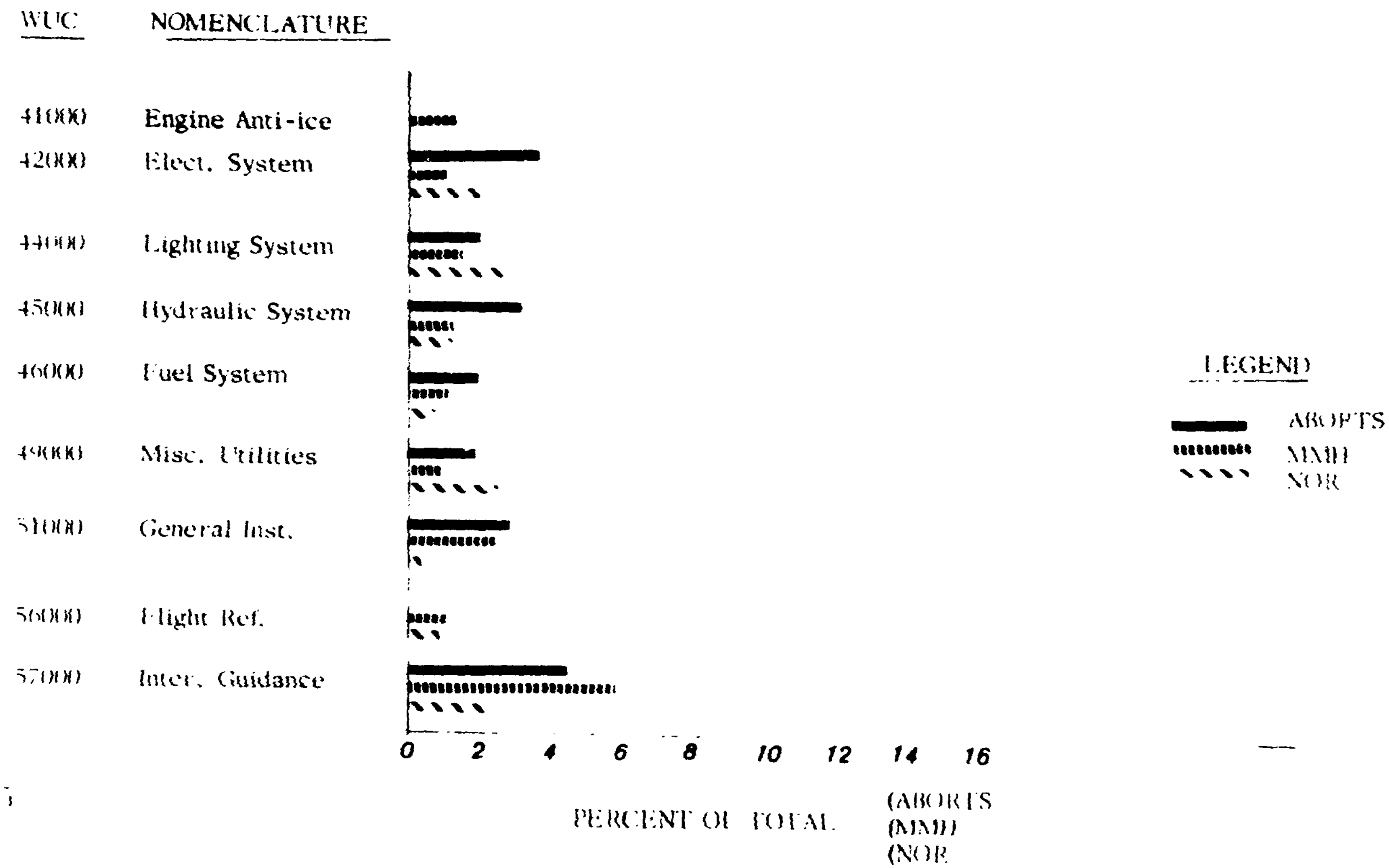
In this report maintenance manhours for the CH-53A and CH-53D aircraft are grouped together since the relative rankings by WUC are nearly identical. See the Chart of Appendix C. Independent rankings will be made for each following report and if any significant differences occur they will be highlighted.

This section provides an accurate indication of which areas of the CH-53 are consuming manhours and reducing availability through aborts and NOR conditions.

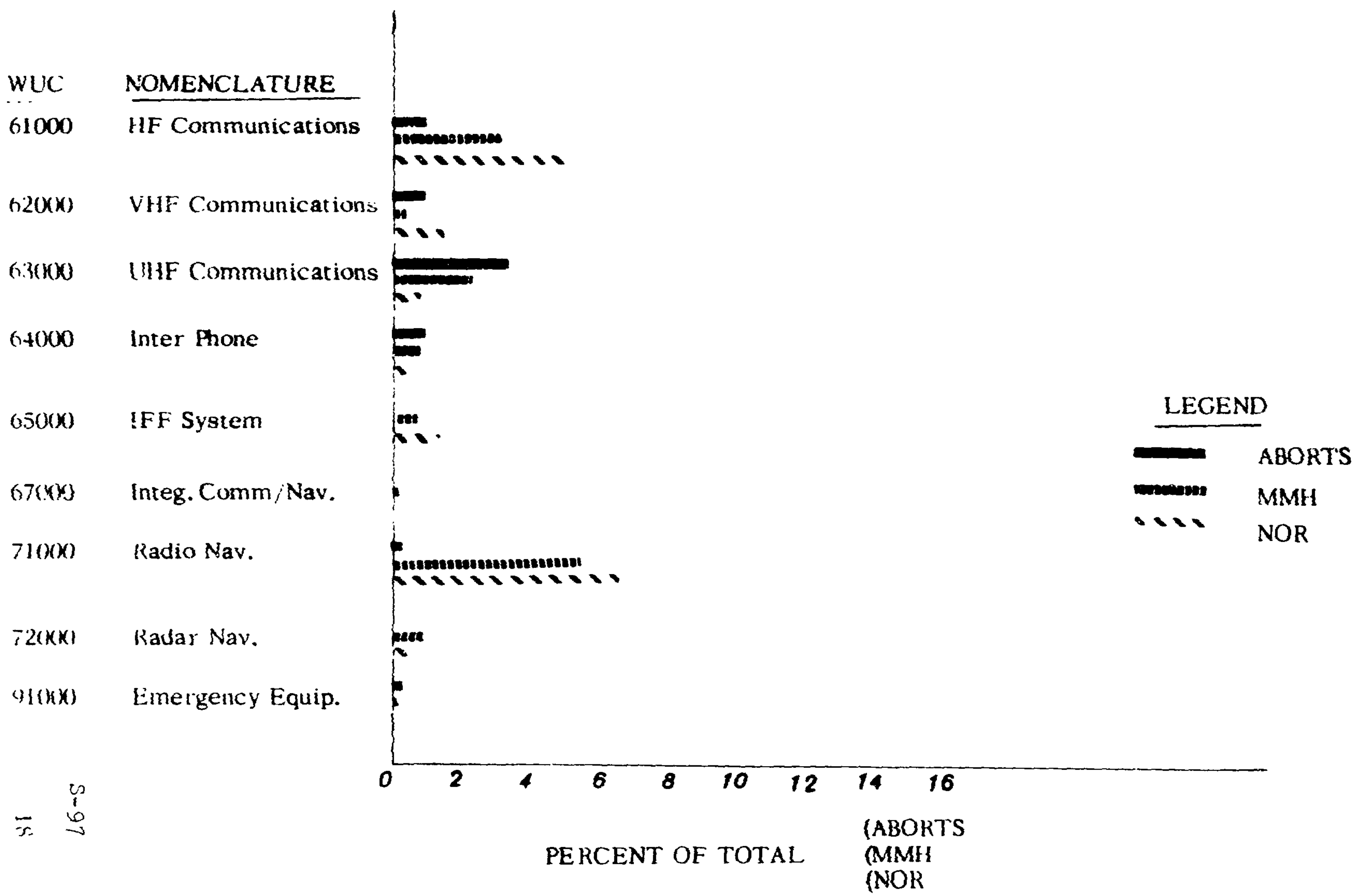
ABORTS, MAINTENANCE MANHOURS, AND NOR BY SYSTEM

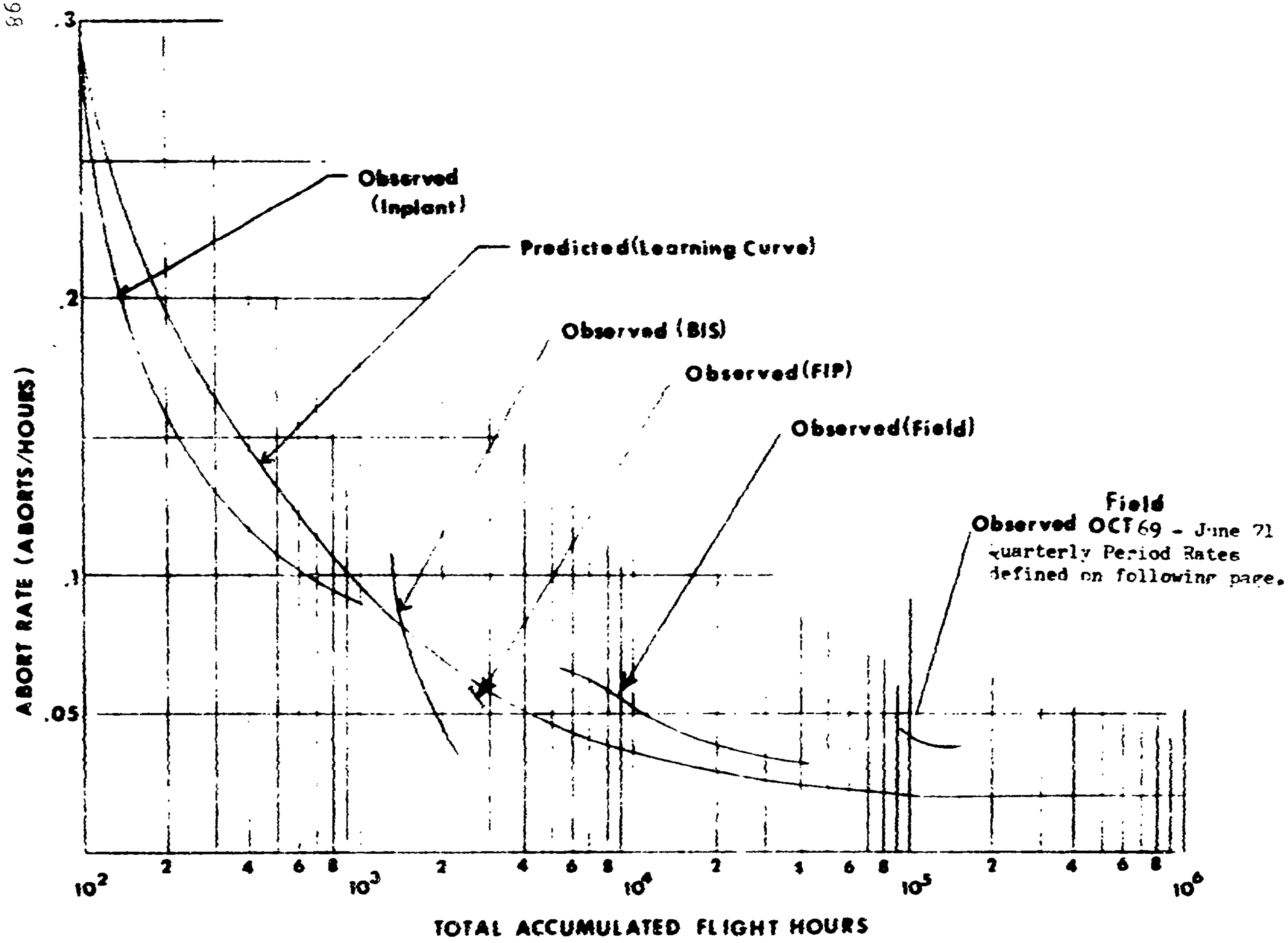


ABORTS, MAINTENANCE MANHOURS, AND NOR BY SYSTEM



ABORTS, MAINTENANCE MANHOURS, AND NOR BY SYSTEM





CH-53A/D Abort Rate Experience versus Predicted

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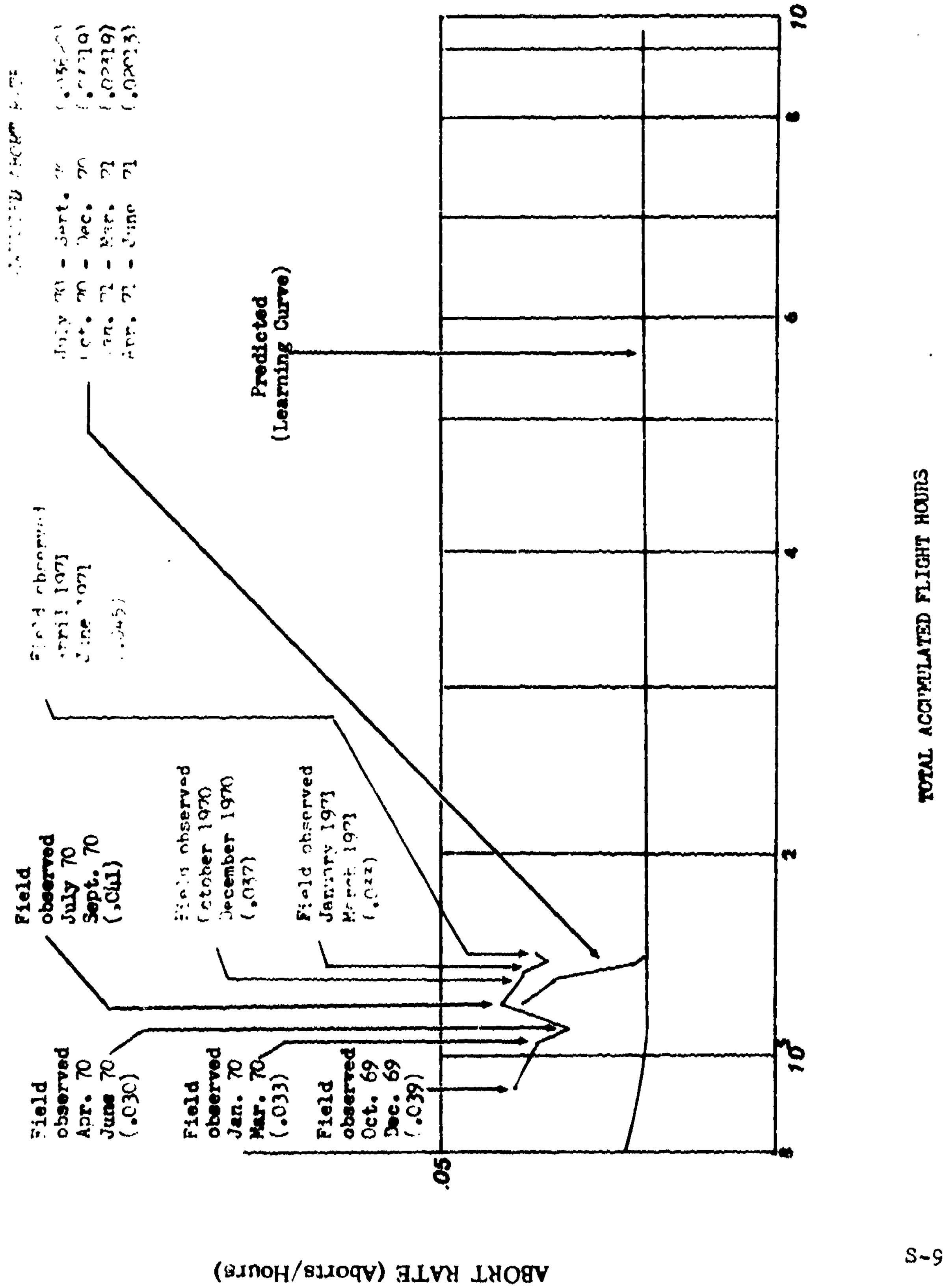

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SECTION II

IMPACT ANALYSIS - INVESTIGATION SUMMARY

The Impact Analysis section of the report studies the logistic considerations of time control components of the CH-53. The concept is not complex but the outcome is significant.

Impact analysis starts with an estimate of fleet requirements for time control components for a specified period. The object is to determine the number of new or overhauled spare components that will be required to support 100% utilization in the fleet. There are several parameters that must be taken into consideration. These include such items as: number of aircraft, new aircraft deliveries, monthly flight hour standards, depot outputs, etc. The other major parameter is defined as Mean Time Between Removal (MTBR) for Overhaul and is the Time Since Overhaul (TSO), for components returning to a depot for any reason. This number is not a reliability figure for the component because it will include returns for such items as handling or maintenance damage, etc. What is determined is the length of time that an average component is available at the user level. Components which are removed for local repair are not considered since they remain at or near the usage site and are expected to be available on a short turn around time.

Fleet requirements can be estimated by dividing the flight hour estimate by the MTBR for Overhaul/Repair. This number of components must then be supplied from the output of Depot facilities and from new spare deliveries. Any difference between requirements and projected deliveries is cause for further analysis and remedial action.

A description of the derivation of the actual numbers, flight hours, and MTBR for overhaul, is contained in Appendix B.

The component investigation portion presents a comprehensive analysis of systems, sub-systems, or components which are adversely affecting aircraft readiness.

3M data forms the base for this section of the report. Two different 3M reports are used to generate the data. A special read-out of the 3M tape supplied to Sikorsky Aircraft provides NOR data. Report number MSO-4790. A2142-01 655-02, "Reliability and Maintainability Summary" provides failure, maintenance action, and manhour data. The data is ranked by contributions to NORS, NORM and component failures and then cross-indexed to show interrelationships between the three catagories. Top problem areas are then chosen for analysis. See Appendix C.

Analysis starts with a search for specific reasons or causes which account for the high ranking of the component. Sikorsky Field Support

Representatives reports and reports from the Sikorsky Readiness Representative at NARF, North Island provide much of this information.

Once specific causes are isolated, a search begins for possible solutions. Solutions are analyzed with the assistance of Product Support and Supply Support and recommendations are formulated.

The text of this section describes the problem areas and presents the recommendations. Following the text are Action Sheets which summarize individual problems and the required action to alleviate that specific problem. Flow Charts are included to reflect the actual status of referenced ECP's highlighting required action and established responsibility. However, since no new items are being introduced in this, the eighth (8th) report, no impact analysis or investigation summary will be presented.

APPENDIX A

ABORT/MANHOUR DATA

ABORTS April 1971 THROUGH June 1971 MANHOURS January 1971 THROUGH June 1971 MSO 4790-A2142-01

WUC	SYSTEM NOMENCLATURE	NO. ABORTS	% TOTAL ABORTS	RANK	53 A/D MANHOURS	% MANHOURS	RANK
11000	Airframe	23	5.46	6	11.840	16.66	1
12000	Fuselage Compartments	7	1.66	17	1.464	2.06	14
13000	Landing Gear System	23	5.46	7	5.379	7.57	5
14000	Flight Controls	68	16.15	1	6,533	9.19	3
15000	Rotor System	46	11.93	3	10.511	14.79	2
22000	Engines	35	8.31	4	4,526	6.37	6
24000	APP	20	4.75	8	1.661	2.34	12
26000	Drives/Transmission	60	14.25	2	5,627	7.92	4
29000	Power Plant Support System	28	6.65	5	3.063	4.31	9
41000	Engine Anti-Ice Comp.	0	0	23	430	.61	24
42000	Electrical System	15	3.56	10	810	1.14	17
44000	Lighting System	8	1.90	14	1,202	1.69	15
450[illegible]	Hydraulic Power Supply	13	3.09	12	976	1.37	16

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WUC	SYSTEM NOMENCLATURE	NO. ABORTS	% TOTAL ABORTS	RANK	53 A/D MANHOURS	% MANHOURS	RANK
46000	Fuel System	8	1.90	15	737	1.04	19
49000	Miscellaneous Utilities	8	1.90	16	609	.86	21
51000	General Instruments	12	2.85	13	1,711	2.41	11
56000	Flight Reference	0	0	24	806	1.13	18
57000	Integrated Guidance	19	4.51	9	3,386	4.76	8
61000	HF Communications	4	.95	18	2,258	3.18	10
62000	VHF Communications	4	.95	19	253	.36	25
63000	UHF Communications	14	3.33	11	1,614	2.27	13
64000	Inter Phone System	4	.95	20	611	.86	22
65000	IFF System	0	0	25	503	.71	23
71000	Radio Navigation	1	.24	21	3,849	5.42	7
72000	Radar Navigation	0	0	26	623	.88	20
91000	Emergency Equipment	1	.24	22	25	.04	26
TOTAL		421	100.99		71,043	99.94	

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APPENDIX B

IMPACT ANALYSIS DATA

1. Derivation of MTBR for Overhaul

A survey of all components processed through the depot facilities since the beginning of the CH-53 program is constantly being conducted. Inputs are being received from Sikorsky Readiness Representatives at NARF, North Island and from the Sikorsky O&R Production Control Department. Components received at a depot without Time Since Overhaul information are disregarded unless the time can be otherwise ascertained.

It should be noted that the numbers so generated do not reflect component reliability, since all causes for return to a depot facility are considered, including no-defect components, handling or maintenance damaged components, etc., are included in the survey. The intent here is not to define a reliability number for the component but to accurately study the loss of RFI components from the fleet supply system for any reason.

Computation is affected on the date noted on the chart. This data is used as an additional tool to assist in isolating areas for analysis and is considered when selecting assemblies to discuss in the Readiness Report.

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MAJOR COMPONENT MEAN TIME BETWEEN REMOVAL HOURS (MTBR)

Statistical Data Accrued from 1967 Through the Period Noted

COMPONENT	JULY 1970	MARCH 1971	JUNE 1971	SEPTEMBER 1971	DECEMBER 1971
Main Gear Box	416. 22	502. 36	490. 69	492. 36	499. 26
Intermediate Gear Box	728. 43	673. 88	732. 98	729. 98	752. 98
Tail Gear Box	499. 62	602. 17	578. 07	606. 90	619. 92
Accessory Gear Box	518. 16	550. 79	558. 81	579. 38	573. 66
Nose Gear Box	490. 00	529. 11	540. 40	536. 26	537. 37
Main Rotor Head	329. 13	382. 20	383. 98	383. 40	383. 30
Swashplate	416. 13	499. 46	472. 73	476. 15	477. 37
Main Rotor Damper	243. 11	285. 25	280. 95	294. 64	295. 20
Sleeve and Spindle	390. 75	403. 43	379. 87	285. 92	315. 63
Tail Rotor Head	465. 36	509. 00	484. 86	483. 30	464. 06
Tail Rotor Servo	549. 94	540. 20	531. 47	584. 09	Not Reported
Primary Servo	325. 22	377. 21	399. 88	417. 99	Not Reported

COMPONENT	JULY 1970	MARCH 1971	JUNE 1971	SEPTEMBER 1971	DECEMBER 1971
AFCS Servo	344.52	399.96	418.18	495.84	Not Reported
Main Rotor Blades	418.40	453.33	442.96	490.85	482.52
Tail Rotor Blades	372.00	326.99	375.05	383.25	383.89

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2. Derivation of Predicted Flight Hours

As of 30 November 1971, 232 aircraft were in inventory (strike aircraft having been eliminated). It is assumed that approximately 5 aircraft will be added to inventory during the balance of calendar year 1971. Based on past history, 2 additional strikes are assumed for 1971. A Utilization Standard of 30.00 flight hours per month per aircraft has been used.

Predicted flight hours per month are obtained by multiplying the average number of aircraft in the fleet for each month by the utilization standard. A summation of monthly totals leads to a gross estimate of 54,360 flight hours for the year with allowances for anticipated NARF PAR induction schedules and known storage periods considered. It should be noted that the flight hour estimate assumes 100% utilization.

APPENDIX C

NORM, NORS AND FAILURE ANALYSIS

Reference:

(a) Reliability and Maintainability Summary - - MSO-4790. A2142-01 dated 20 August 1971. The failure statistics reflected are based on maintenance and flight data for the period from January 1971 through June 1971. This summary was selected for the generation of data for the eighth CH-53 Readiness Report and provides the latest complete accumulated information available.

(b) High NORM/NORS Data Base - - read out of 3M tape supplied to Sikorsky Aircraft reflecting data on all fifth level WUC's. This summary also covers the period from January 1971 through June 1971.

1. NORM, NORS Items Ranking

(a) Identification and ranking of sub-system WUC's is based on the contribution of the WUC item, measured in hours, to the total reported NORM hours. The percentage of contribution the item makes to the total NORM hours is also given.

(b) WUC ranking for NORS items is developed in the same manner as for the NORM items.

UNSCHEDULED NORM ITEM RANKING

WUC	NOMENCLATURE	NORM HRS.	% OF NORM	RANK
15110	Rotary Wing Head	3,256.3	14.17	1
14410	Forward Cabin Flight Control Components	1,293.1	5.58	2
22600	T-64 Engine	1,101.5	4.79	3
14A10	R/W Pylon Hydraulic Components	966.7	4.21	4
57560	Automatic Flight Control System	873.8	3.80	5
15310	Rotary Wing Blades	776.1	3.38	6
26270	Main Gear Box	606.6	2.64	7
22660	Main Fuel System (T64)	585.1	2.55	8
26B30	APP Clutch Components	478.3	2.08	9
71430	AN/ARN 52 Tacan Set	454.9	1.98	10
13110	MLG Mechanical Components	398.0	1.73	11
45110	Utility Hydraulic System Components	385.9	1.68	12
15220	Blade Positioning Components	381.7	1.66	13
51130	Engine/Gear Box Instruments	378.2	1.65	14
26720	Nose Gear Box Components	341.8	1.49	15

NORS ITEM RANKING

WUC	NOMENCLATURE	NORS HRS.	% OF NORS	RANK
15110	Rotary Wing Head	9,453.4	7.31	1
71430	AN/ARN52(V) Tacan Set	6,471.6	5.01	2
15220	Blade Positioning Components	5,477.8	4.24	3
12710	Cargo Hook System Components	5,306.6	4.10	4
14410	Forward Cabin Flight Control Components	5,234.4	4.05	5
12610	Cargo Winch Components	4,410.2	3.41	6
44110	Exterior Lights	4,096.9	3.17	7
612EO	AN/ARC 131 VHF/FM Radio Set	3,976.4	3.08	8
26B30	APP Clutch Components	3,786.6	2.93	9
14A10	R/W Pylon Hydraulic Components	3,763.0	2.91	10
29510	Engine Ignition/Starting Components	3,517.9	2.72	11
15100	Rotary Wing Head	3,340.9	2.58	12
22660	Main Fuel System (T-64)	3,283.1	2.54	13
51130	Engine Gear Box Instruments	3,282.0	2.54	14
49510	APP Heater Fire Extinguisher Components	3,052.7	2.36	15

TOTAL SCHEDULED NORM HOURS	-	21.835.1
TOTAL UNSCHEDULED NORM HOURS	-	22,987.1
TOTAL NORS HOURS	-	129,302.6
TOTAL AWAITING MAINTENANCE HOURS	-	112,151.7
TOTAL NOR HOURS	-	286,268.4

Reference 3M Tabulation NOR Summary - January 1971 - June 1971

2. Failure Ranking

(a) Twenty-seven (27) system work unit codes are ranked by the number of failures the specific WUC contributed to the overall number of failures reported. The percentage each system contributed is also shown.

SYSTEM PERFORMANCE BY WORK UNIT CODE AND RANKING

RANK	WUC	NOMENCLATURE	PREVIOUS REPORT	TOTAL FAILURES	%	TOTAL MAINT. ACT.	%	TOTAL MANHOURS	%
1	11000	Airframe	1	1,975	17.43	2,337	13.05	11,840	16.66
2	15000	Rotor System	2	1,219	10.76	1,942	10.85	10,511	14.79
3	13000	Landing Gear System	3	1,020	9.00	1,407	7.86	5,379	7.57
4	26000	Transmission	4	881	7.78	1,344	7.51	5,627	7.92
5	14000	Flight Controls	5	844	7.45	1,370	7.65	6,533	9.19
6	29000	Power Plant Support	6	646	5.70	938	5.24	3,063	4.31
	SUB-TOTAL			6,585	58.12	9,338	52.16	42,953	60.44
7	71000	Radio-Navigation	10	489	4.32	954	5.33	3,849	5.42
8	51000	Instruments	7	487	4.30	832	4.65	1,711	2.41
9	22000	Turbo Shaft Engine	8	468	4.13	734	4.10	4,526	6.37
10	57000	Integrated Guidance	9	434	3.83	835	4.66	3,386	4.76
11	44000	Lighting System	11	389	3.43	560	3.13	1,202	1.69
12	12000	Fuselage Compartment	12	375	3.31	582	3.25	1,464	2.06

* Sub-Total of those work unit codes accounting for a least (5) percent of all system failures.

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SYSTEM PERFORMANCE BY WORK UNIT CODE AND RANKING (continued)

RANK	WUC	NOMENCLATURE	PREVIOUS REPORT	TOTAL FAILURES	%	TOTAL MAINT. ACT.	%	TOTAL MANHOURS	%
13	61000	HF Communications	15	319	2.81	636	3.55	2,258	3.18
14	24000	APP (Airborne)	13	311	2.74	614	3.43	1,661	2.34
15	45000	Hydraulic Power	14	239	2.10	371	2.07	976	1.37
16	63000	UHF Communications	16	226	1.99	498	2.78	1,614	2.27
17	42000	Electrical System	17	182	1.60	315	1.76	810	1.14
18	56000	Flight Reference	20	153	1.35	307	1.71	806	1.13
19	49000	Misc. Utilities	19	140	1.24	286	1.60	609	.86
20	64000	Interphone System	18	125	1.10	279	1.56	611	.86
21	46000	Fuel System	21	115	1.01	217	1.21	737	1.04
22	65000	IFF Systems	23	83	.73	183	1.02	503	.71
23	72000	Radar Navigation	24	77	.68	127	.71	623	.88
24	62000	VHF Communications	22	51	.45	86	.48	253	.36

SYSTEM PERFORMANCE BY WORK UNIT CODE AND RANKING (continued)

RANK	WUC	NOMENCLATURE	PREVIOUS REPORT	TOTAL FAILURES	%	TOTAL MAINT. ACT.	%	TOTAL MANHOURS	%
25	41000	Surface Ice Control	25	50	.44	79	.44	430	.61
26	91000	Emergency Equipment	26	14	.12	33	.18	25	.04
				4,727	41.68	8,528	47.62	28,054	39.50
				6,585	58.12	9,338	52.16	42,953	60.44
				11,312	99.80	17,866	99.78	71,007	99.94

TOTAL FLIGHT HOURS ------------ 13,621

TOTAL FAILURES ----------------- 11,331

TOTAL MAINTENANCE ACTIONS --- 17,905

TOTAL MANHOURS ---------------- 71,073

3. High NORM, NORS and Component Failure Ranking

(a) The preceding NORM, NORS and Component Failure Charts have been combined here to facilitate comparison. The high fourteen (14) WUC's for each category were selected. (Ref. Chart One).

(b) The second chart shows the interrelationship of the WUC's referenced on their respective NORM, NORS and Component Failure Rankings. The 42 codes were consolidated into 15 parent system WUC's for this presentation.

HIGH NORM, NORS, AND SYSTEM FAILURE RANKING

NORM		NORS		SYSTEM FAILURES	
WUC	NOMENCLATURE	WUC	NOMENCLATURE	WUC	NOMENCLATURE
15000	Rotor System	15000	Rotor System	11000	Airframe
14000	Flight Controls	14000	Flight Controls	15000	Rotor System
26000	R/W Drives/Trans.	12000	Fuselage Compartment	13000	Landing Gear System
22000	Turbo Shaft Engines	26000	R/W Drives/Trans.	26000	R/W Drives/Trans.
11000	Airframe	71000	Radio Navigation	14000	Flight Controls
24000	APP (Airborne)	61000	HF Comm. System	29000	Power Plant Inst'l.
13000	Landing Gear System	11000	Airframe	71000	Radio Navigation
57000	Integrated Guidance	22000	Turbo Shaft Engines	51000	Instruments
29000	Power Plant Inst'l.	24000	APP (Airborne)	22000	Turbo Shaft Engines
51000	Instruments	29000	Power Plant Inst'l.	57000	Integrated Guidance
71000	Radio Navigation	44000	Lighting Systems	44000	Lighting System
42000	Electrical System	49000	Misc. Utilities	12000	Fuselage Compartment
46000	Fuel System	13000	Landing Gear System	61000	HF Comm. System
45000	Hydraulic Power Supply	42000	Electrical System	24000	APP (Airborne)

INTERRELATIONSHIP OF NORM, NORS, SYSTEM FAILURES

WUC	NOMENCLATURE	NORM	NORS	SYSTEM FAILURES
11000	Airframe	x	x	x
12000	Fuselage Compartments	o	x	x
13000	Landing Gear System	x	x	x
14000	Flight Controls	x	x	x
15000	Rotor System	x	x	x
22000	Turbo Shaft Engines	x	x	x
24000	APP (Airborne)	x	x	x
26000	R/W Drives	x	x	x
29000	Power Plant	x	x	x
42000	Electrical System	x	x	o
44000	Lighting Systems	o	x	x
51000	Instruments	x	o	x
57000	Integrated Guidance	x	o	x
61000	HF Communication System	o	x	x
71000	Radio Navigation	x	x	x

The 15 system work unit codes described above are derived by consolidating the WUC's shown on the previous page NORM, NORS, SYSTEM FAILURE RANKING CHART to the system level.
Ranking in the above chart was determined by the items appearance on two or more of the 3 reports.

x Indicates item appeared on respective NORM, NORS or FAILURE LISTING.
o Indicates item did not appear on the respective list.